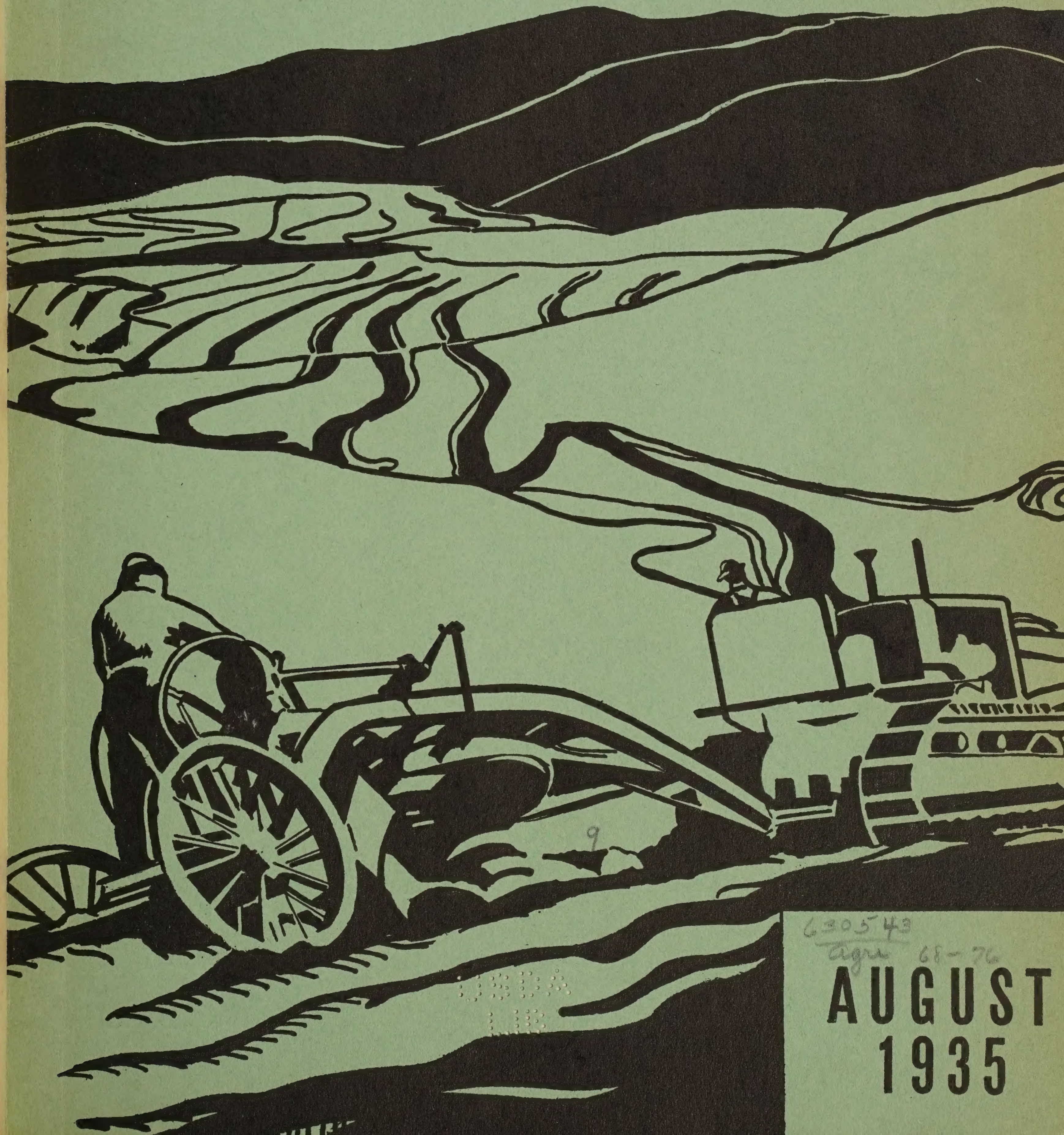
SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE · WASHINGTON



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WELLINGTON BRINK EDITOR

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

H. H. BENNETT
Chief, Soil Conservation Service

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AUGUST · 1935

ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON

A MESSAGE FROM THE SECRETARY OF AGRICULTURE

Soil erosion control, to be effective, permanent, and economically feasible, involves more than the use of vegetative and engineering methods. It involves, also, general land-use planning, proper crop rotations, controlled livestock grazing, and the application of other sound farm-management practices. Hence, practically every branch of the Department is concerned, should be called on, and should cooperate at all times in shaping and carrying forward a practicable program. Similarly, the Soil Conservation Service should cooperate with the other branches of the Department in order to utilize to the greatest extent possible all existing resources and information.

It is largely through cordial working agreements with the State colleges, the experiment stations and the extension services that the Department is accustomed to reach the individual farmer. And it is upon such agencies that we are relying for practical assistance in making the soil conservation program effective.

Many have spoken to me of the sincere desire of officials in all branches to help make this new undertaking a truly successful one. I am very much gratified, too, by reports coming to me from the field. The spirit which pervades soil conservation ranks everywhere enables us to go forward with confidence.

H A Wallace

EXPANDED DEMONSTRATION PROGRAM GETS UNDER WAY

Ninety-four new erosion control projects were announced on August 5, with allocation by the President of $27,500,000 of Works Relief funds.

Selection of areas was premised on relief rolls, erosion conditions, cooperative attitude of farmers, and suitability for demonstration purposes. Sites were inspected by State agricultural agencies and representatives of the Soil Conservation Service in advance of designation.

Wide Coverage

The expanded program, including as a nucleus the 47 existing projects, will embrace demonstration areas in 41 States. The average unit of operations will approximate 25,000 acres in size.

Regional directors, backed by the experience gained under the first 2 years of erosion-control work, are reported everywhere as prepared to get the new projects under way speedily. They have been instructed that under the provisions of the Works Relief Act, they must draw 90 percent of the additional labor required from local relief rolls wherever possible.

Varied Treatment

A variety of land problems will be encountered among the new demonstrations, involving many forms of gullying, sheet erosion, flood and wind destruction. The enlarged program will deal with a cross-section of erosion conditions of agricultural America. It will involve comprehensive land planning and farm management. In some places dams will be built or gullying otherwise checked. Terraces will be constructed. Strip-cropping, contour cultivation, and forestation will be extensively employed. Plant introductions and native vegetation will be used. Combinations of two or more of these measures will be brought to bear in most instances.

Many Groups Involved

As heretofore, success will be contingent upon the cooperation of farmers, civic groups, agricultural agencies, State and local officials.

A number of States will have erosion-control projects for the first time, among them Florida, Idaho, Indiana, Maine, Maryland, Michigan, Montana, Nevada, North Dakota, Utah, and Wyoming with 1 each.

Texas, the largest State in area, also leads in the number of projects with 10 new ones and 3 already under way. Oklahoma comes next, with a total of 10 projects, 8 of which are new.

Following is the distribution in other States:

Alabama.—Two new projects. One existing project.

Arizona.—Two existing projects.

Arkansas.—Four new projects. Two existing projects.

California.—Three new projects. Three existing projects.

Colorado.—Two new projects. Two existing projects.

Georgia.—Three new projects. Two existing projects.

Illinois.—Two new projects. One existing project.

Iowa.—Four new projects.

Kansas.—Three new projects. One existing project.

Kentucky.—Two new projects. One existing project.

Louisiana.—Four new projects. Two existing projects.

Minnesota.—One new project. Three existing projects.

Mississippi.—Four new projects. One exisiting project.

Missouri.—Three new projects. Two existing projects.

Nebraska.—Two new projects. One existing project.

New Jersey.—Two new projects. One existing project.

New Mexico.—One new project. One existing project.

New York.—Two new projects. One existing project.

North Carolina.—Five new projects. Three existing projects.

Ohio.—Three new projects. One existing project.

Oregon.—One new project. One existing project.

Pennsylvania.—Three new projects. One existing project.

South Carolina.—Three new projects. Two existing projects.

South Dakota.—One new project. Two existing projects.

Virginia.—One new project. Two existing projects.

Washington.—One new project. One existing project.

West Virginia.—One new project. One existing project.

Wisconsin.—Two new projects. One existing project.

ACT OF CONGRESS ASSURES PERMANENCE TO SOIL CONSERVATION PROGRAM

Because of its vital interest not only to members of the Soil Conservation Service but to everyone interested in conservation and in agriculture, we reproduce Public, no. 46, passed by the Seventy-fourth Congress on April 27, 1935, "To provide for the protection of land resources against soil erosion, and for other purposes."

On the day the act was approved the Secretary of Agriculture officially designated the Soil Erosion Service as the agency to carry out its provisions. Thus the emergency Soil Erosion Service became the permanent Soil Conservation Service.

AN ACT

To provide for the protection of land resources against soil erosion, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it is hereby, recognized that the wastage of soil and moisture resources on farm grazing, and forest lands of the Nation, resulting from soil erosion, is a menace to the national welfare and that it is hereby declared to be the policy of Congress to provide permanently for the control and prevention of soil erosion and thereby to preserve natural resources, control floods, prevent impairment of reservoirs, and maintain the navigability of rivers and harbors, protect public health, public lands and relieve unemployment, and the Secretary of Agriculture, from now on, shall coordinate and direct all activities with relation to soil erosion and in order to effectuate this policy is hereby authorized, from time to time—

(1) To conduct surveys, investigations, and research relating to the character of soil erosion and the preventive measures needed, to publish the results of any such surveys, investigations, or research, to disseminate information concerning such methods and to conduct demonstrational projects in areas subject to erosion by wind or water;

(2) To carry out preventive measures, including, but not limited to, engineering operations, methods of cultivation, the growing of vegetation, and changes in use of land;

(3) To cooperate or enter into agreements with, or to furnish financial or other aid to, any agency, governmental or otherwise, or any person, subject to such conditions as he may deem necessary, for the purposes of this Act; and

(4) To acquire lands, or rights or interests therein, by purchase, gift, condemnation, or otherwise, whenever necessary for the purposes of this Act.

Sec. 2. The acts authorized in section 1 (1) and (2) may be performed—

(a) On lands owned or controlled by the United States or any of its agencies, with the cooperation of the agency having jurisdiction thereof; and

(b) On any other lands, upon obtaining proper consent or the necessary rights or interests in such lands.

Sec. 3. As a condition to the extending of any benefits under this Act to any lands not owned or controlled by the United States or any of its agencies, the Secretary of Agriculture may, insofar as he may deem necessary for the purposes of this Act, require—

(1) The enactment and reasonable safeguards for the enforcement of State and local laws imposing suitable permanent restrictions on the use of such lands and otherwise providing for the prevention of soil erosion;

(2) Agreements or covenants as to the permanent use of such lands; and

(3) Contributions in money, services, materials, or otherwise, to any operations conferring such benefits.

Sec. 4. For the purposes of this Act, the Secretary of Agriculture may—

(1) Secure the cooperation of any governmental agency;

(2) Subject to the provisions of the civil-service laws and the Classification Act of 1923, as amended, appoint and fix the compensation of such officers and employees as he may deem necessary except for a period not to exceed eight months from the date of this enactment, the Secretary of Agriculture may make appointments and may continue employees of the organization heretofore established for the purpose of administering those provisions of the National Industrial Recovery Act which relate to the prevention of soil erosion, without regard to the civil-service laws or regulations and the Classification Act, as amended; and any persons with technical or practical knowledge may be employed and compensated under this Act on a basis to be determined by the Civil Service Commission; and

(3) Make expenditures for personal services and rent in the District of Columbia and elsewhere, for the purchase of law books and books of reference, for printing and binding, for the purchase, operation, and maintenance of passenger-carrying vehicles, and perform such acts and prescribe such regulations as he may deem proper to carry out the provisions of this Act.

Sec. 5. The Secretary of Agriculture shall establish an agency to be known as the "Soil Conservation Service", to exercise the powers conferred on him by this Act and may utilize the organization heretofore established for the purpose of administering those provisions of sections 202 and 203 of the National Industrial Recovery Act which relates to the prevention of soil erosion, together with such personnel thereof as the Secretary of Agriculture may determine, and all unexpended balances of funds heretofore allotted to said organization shall be available until June 30, 1937, and the Secretary of Agriculture shall assume all obligations incurred by said organization prior to transfer to the Department of Agriculture. Funds provided in H. J. Res. 117, "An Act making appropriation for relief purposes" (for soil erosion) shall be available for expenditure under the provisions of this Act; and in order that there may be proper coordination of erosion-control activities the Secretary of Agriculture may transfer to the agency created under this Act such functions, funds, personnel, and property of other agencies in the Department of Agriculture as he may from time to time determine.

Sec. 6. There are hereby authorized to be appropriated for the purposes of this Act such sums as Congress may from time to time determine to be necessary.

Approved, April 27, 1935.

STRIP-CROPPING TERMS DEFINED

Typical strip-cropping near East Bethlehem, Pa.

In a recent revision of the mimeographed circular, Strip Cropping, by Lyman Carrier, chief agronomist, and Walter V. Kell, associate, several terms are defined which are frequently used in discussing the practice of strip-crop farming as applied to erosion control.

The practices, because of varying conditions, are not always uniform in different States; therefore, a better understanding of the terms used in describing them should result in a clearer conception of these practices

The term " strip-cropping ", as applied to a cropping practice employed by the Soil Conservation Service, means the production of crops in long strips placed crosswise of the line of slope approximately on the contour. The width of the strips will vary, depending on the erodibility of the soil and the degree of slope.

The term " field-stripping " refers to a modified form of strip-cropping in which the field is divided into straight parallel strips laid out crosswise of the general slope.

The terms " buffer " or " spreader " strips refer to narrow, permanent, contour strips of erosion-resisting vegetation which are not a part of the rotation and may or may not be harvested. The strips are usually about one drill's width or wider. Buffer or spreader strips may also be composed of small grain, legumes, or sod usually seeded ahead of the general field seeding.

" Rotation strip-cropping " is a term referring to the rotation of the general farm crops grown in the strips.

These systems should not be confused with permanent strips, where trees, vines, briar berries, honeysuckle, and grass are grown on especially vulnerable parts of slopes to afford permanent protection.

Under conditions where it can be practiced, strip cropping is an effective method of controlling erosion. It is especially suited to general farming regions where a hay crop is an important feature of the cropping system. The principle involved can be practiced on any slope capable of being cultivated, but it is essential that the fields or strips be laid out as nearly as practicable on contour lines. When the strips deviate from the contour, grass covered waterways should be maintained to provide safe drainage of accumulated run-off water without danger of erosion.

Buffer or spreader strips; one drill's width (10 feet) of winter wheat seeded in the spring on summer-fallow ground. Eastern Washington.

HOW SILT IS MEASURED ON PROJECT STREAMS

By John A. Allis

Stillwater Creek Project

The appearance of a muddy stream of water naturally raises the question as to how much soil material is being carried out of the area drained by that stream. To obtain definite information regarding this subject, measurements of the actual flow of water and determinations of the amount of material carried in suspension by three streams in the soil erosion project at Stillwater, Okla., are being made by the United States Geological Survey.

As the flow of streams during periods of low water is affected by the ground-water conditions, it is important to know the fluctuation of the ground-water table. This fluctuation is determined by making observations on the ground-water level in wells scattered throughout the project.

Many Readings Required

Results of determinations of load of suspended material and of observations of ground-water levels must be obtained for a considerable period of time in order to afford a reliable index to the changes that are likely to take place.

Two stream-gaging stations, one on Stillwater Creek and one on the West Fork of Brush Creek, are located within the project area. Another gaging station on Council Creek outside the area duplicates as nearly as possible the physical features of the other two stations. Investigations made at these three stations will give a comparison of stream flow, ground-water levels, and silt movement on the project area with that of a similar untreated area.

Each of the stations is equipped with an automatic gage-height recorder housed in a wooden shelter, which is provided with an outside and an inside staff gage, a stilling well, and an intake from the stream. These recorders, which are visited at frequent intervals by the resident engineer, furnish a graph which shows the actual state of the stream at all times.

Basis for Calculations

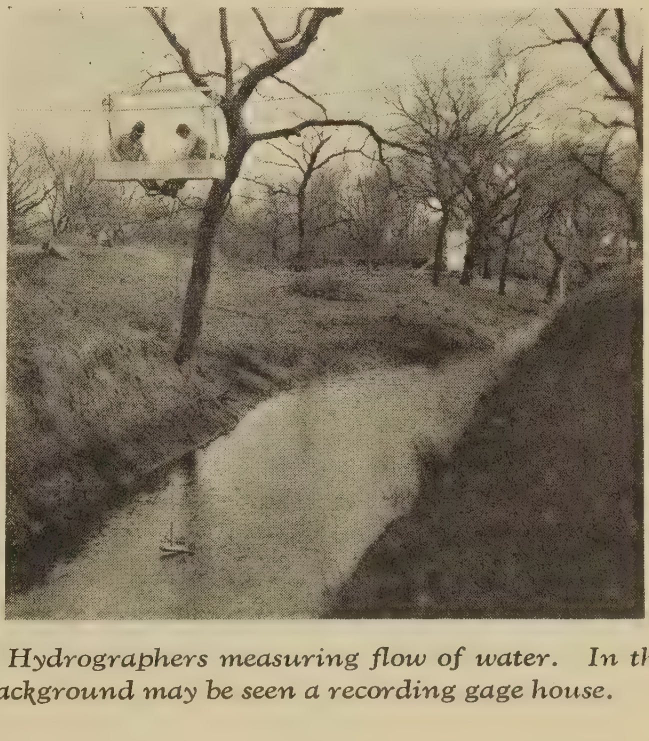
Discharge measurements are made by the hydrographer which show the amount of water, in cubic feet per second, passing the gage. A record is kept of each discharge measurement and of the stage of the stream at the time it is made. With a sufficient number of reliable discharge measurements made throughout the range of stage of the stream together with the gage-height graph, it is possible to make a rating curve from which the discharge at all times can be calculated.

Silt samples are collected daily during periods of normal flow. During flood stages samples are collected at intervals ranging from half an hour to two hours. Each sample is marked, showing the time, gage height, and sampling point. Usually three samples are taken for each set.

These samples are analyzed for silt content, in parts per million, at the field laboratory. The Washington office takes up the computations at this point and determines the quantity of silt passing the gaging station. These computations show the loss of soil from land in the drainage area.

Ground-Water Fluctuations

In addition to the 3 gaging stations described above, 16 wells supplied by ground water and 9 rain-gage stations are maintained. One of the wells is equipped with a water-stage recorder, which shows the height of the ground water at all times. The other wells are visited weekly and readings made to show the fluctuation of the ground water. Three of the rain-gage sta-



Hydrographers measuring flow of water. In the background may be seen a recording gage house.

tions are equipped with self-registering recorders which show the amount, intensity, and duration of the rain. The other stations are standard rain gages, which are visited daily by the observers.

Difficulty has been experienced in collecting all the desired data, as the run-off is large and the peak flows are of relatively short duration. Several of the peak flows have occurred at night, and due to the weather conditions that cause such rises, the work has been hampered. A lighting system is being developed whereby it will be possible to make discharge measurements at night. It has, however, been the practice to collect silt samples at all hours.

During periods of normal flow it is necessary to make discharge measurements at frequent intervals in order to detect any changes in the relation between stage and discharge and to develop the rating curve to greater accuracy. During such periods it is possible to complete the field data which have been collected, in order that they may be submitted to the district and Washington offices for further computations and publication.

Since the data are of so technical a nature, much time and study are required to determine fully the effect of soil and moisture conservation practices on stream flow, silt loads, and ground-water level. For this reason no final computations have yet been made.

TEACHING LAND THRIFT TO HIGH SCHOOL BOYS

Realizing that the high-school boys of today will be the farmers of tomorrow, and that the inculcation of principles of land preservation in the minds of the students will be definitely reflected in the farming practices of the future, school officials and directors at Minden, La., have arranged that practical class instruction in erosion-control work be given to every high-school youth in Webster Parish.

Supt. E. S. Richardson and the 10 high-school principals of the parish have agreed to excuse high-school boys from their regular studies for 3½ days a month in order that they may take advantage of classes conducted by department heads of the local project.

Varied Experience

A. H. Bean, soils expert, and J. W. Hammett, in charge of game conservation and rodent control, will explain and demonstrate the work of their departments. A. C. Morris, agronomist, and F. S. Edmiston, chief engineer, will direct the students in the actual work of building a terrace, constructing a terrace outlet and varied types of dam structures in gully control. In addition, the principle of strip-cropping will be explained and a strip-crop planted by the boys.

W. E. Dee, chief of range management, will put in approximately an acre of pasture, again having the high-school boys do the actual work. A. S. McKean, forester, will explain his phase of the work and the value of trees and forest areas to the farmer, and have the school boys plant a small forest tract.

The plots upon which the program will be carried out are so located that students can follow up the first work and see from day to day the advantages of the program being put into use on the farms of this area.

"We want every high-school boy in the parishes where we may be operating to have first-hand information regarding the type of work which we are putting into practice in this section", says H. M. Mimms, acting regional director. "Our work with the schools of Webster Parish was so successful and was met with such enthusiasm by the pupils, the parents, and the teachers that we expect to carry on during the next school year on an enlarged scale. There is no better method of sending our practices and plans of proper land utilization and preservation into the farm homes of our area than through the high-school boys, most of whom already live on farms."

From the South Tyger River project, South Carolina, comes word of a transplant bed established at Duncan, where 1,200,000 loblolly pine seedlings, too small for field planting the past season, have been transplanted.

The wild-life work in the Coon Creek watershed, Wisconsin, has shown considerable progress since its beginning in the spring of 1934. Farmers in the area planted several hundred patches of mixed grains for the feeding of game birds during the winter. Cover plantings of spruce, wild plum, vines, and so forth, were installed with the food patches for further protection.

Although he has but recently terraced his land, Dave Cameron, in the Fishing Creek area, South Carolina, reports that a 2.18-inch rainfall failed to cause any breaks. Six waterways were made on the 325 acres.

PASTURE CONTOURING ACHIEVES MULTIPLE RESULTS

By D. V. Stapleton

Okatibbee River, Miss., Project

Contour furrowing in pastures—with which this article is particularly concerned—is proving its several values on the Okatibbee River project, where it is rapidly gaining headway as a farming practice.

Here it is demonstrating its value in conserving moisture, in conserving fertility, in checking and preventing erosion, in keeping grass seed from washing away, and in controlling run-off water, thereby minimizing flood dangers.

The popularity of contour furrowing is growing not only with the local soil erosion staff but with farmers within the area, and is meeting with approval among business and professional people and leading citizens throughout the State of Mississippi. Hill farmers are interested in it as a device for conserving fertility, preventing erosion and holding moisture. They hail its ability to hold on the pasture the grass and clover seeds, that would in many cases travel with the water down the slopes to the streams below. Lespedeza seed is very light in weight and is easily carried down slopes by water. Citizens located in lowlands and Delta sections are also becoming enthusiastic about contour furrowing of open pastures and idle lands on the slopes above and even suggest that all sparsely-timbered slopes be treated similarly as a means of minimizing flood conditions. Many pastures in the southeastern part of the United States were formerly cultivated fields and in many cases the old row ridges can still be seen. These ridges do not interfere with mowing. Yet, if constructed on the contour they would unquestionably have a considerable water-holding power. Such ridges or rolls are from 4 to 6 inches high.

Furrows Become Rounded

Contour furrows have a rather rugged appearance immediately after they are constructed. Mowing would probably be impossible the first year. Some farmers have raised objection on that account, but the rains, cattle, and other natural means will smooth these furrows down, after which they will have the appearance of a roll and will not materially interfere with mowing. Contour furrows are usually placed from 20 to 30 feet apart, depending upon the slope, but they may be placed closer since they are inexpensive and can be built by the farmer himself at odd times.

The accompanying illustration gives an idea of the contour furrows as they appear in this section. The staking out of contour furrows in pastures is much more simple, from an engineering standpoint, than the designing of a terracing system on cultivated areas. There are no set rules as to the location of contour furrows. It is largely a matter of putting into use plenty of common sense. An average person, with some experience, can stake out and lay off furrows on the contour, since one of the main objectives is to hold the maximum amount of water. In order to increase the holding capacity each end should be turned up the slope slightly. Care should be exercised to construct the furrows so as to prevent concentration of water that will run off. For the average land in this section, four furrows with an 8-inch turning plow is sufficient.

Each lineal foot of contour furrow 6 inches high on a 10-percent slope has a water-holding capacity of 1.75 cubic feet, or 13.09 gallons.

It must be remembered that when the slope of land is increased four times, the speed of water flowing over it is about doubled; the cutting power is multiplied by 4, the power to carry soil is multiplied by 32, and the size of particles it can carry is multiplied by 64 (Wisconsin Circular No. 249).

Variables Enter

There are a number of variables entering in that make it impossible to figure the amount of water that a given number of contour furrows may prevent from reaching the streams below in a given time, but we do know the actual holding capacity. In other words, if a 4-inch rain falls during a 24-hour period, these variables make it impossible to determine the amount of water that soaks into the ground and the amount that gets away. It is very probable, however, that during a heavy rainy spell of from 48- to 72-hours duration, contour furrows should cause to soak into the ground and evaporate from 2 to 4 times their holding capacity.

During dry summers when pastures begin to fail, the grass is greenest just above the contour furrows. The conclusion reached by the McNeill, Miss., Branch Experiment Station is that these furrows in pastures can be justified from a moisture-holding standpoint alone, even in a humid area. We are of the opinion that pasture contour furrowing in the hill section of Mississippi can be justified from the standpoint of either of the purposes mentioned herein. It is perhaps the general belief that not only pasture slopes, but sparsely timbered slopes, as well, should be contoured. This would suffice until sparsely timbered areas could be reforested and the young trees take hold.

Project no. 21 at Meridian has contoured more than 2,000 acres of pasture slopes on 80 farms. A method that seems to be satisfactory is to run contour lines at twice the distance of the intervals desired and simply plow a furrow half way between. This furrow may not be exactly on the contour at all points, but if care and practical judgment is exercised it will serve the purpose well.

Theoretically, the water-holding capacity of the contour furrows on a 640-acre pasture with an average 10 percent slope and furrows averaging 20 feet apart is approximately 20,000,000 gallons of water. Contour furrows prevent concentration of water. They therefore give the denuded and overgrazed spots a chance to become well sodded again.

Woven Wire Useful

From the Sangamon River, Illinois, project comes the suggestion that idle rolls of woven wire be put to the task of checking gullies. An observer there has noted many such rolls of old wire lying about farms, some of them reposing in gullies in such a way as to add to the erosive action.

The Soil Conservation Service has built several thousand dams of wire, brush, and posts. Hedge brush and posts were used in most of the dams and were furnished by the farmers. Several thousand dams of other types have been constructed with materials which cost little, such as brush and posts, rock, earth, and sod.

A feature which makes these gully dams valuable is that any farmer can build them. They should be so constructed that water can flow neither around them nor under them.

Typical method of constructing pasture contour furrows.

ONE HARD RAIN DID THIS

By E. B. Deeter

Soil Erosion Experiment Station, Temple, Tex.[1]

A single torrential rainfall gave dramatic emphasis recently to the value of strip-cropping as a means of preventing soil losses. As a result of the careful records which have been kept by the Soil Erosion Station at Temple, Tex.—which, in turn, are the progeny of ingenious methods and devices of measurement—we are able to gain a fair portraiture of what happens to mother earth when the forces of man and nature unite in a work of mischief.

Serves Wide Area

The station serves approximately 15,000,000 acres of land, comprising the blackland prairie and part of the grand prairie. The principal soils are Houston clay or Houston black clay (blackland prairie), and San Saba or Crawford clay (grand prairie).

The rainfall of April 2, ranging at different places from 1.09 to 1.72 inches, produced some striking results. The rate of intensity was approximately 4 inches per hour. Land planted to corn, with rows up and down a 4-percent slope, eroded at rates ranging from 5 tons to nearly 10 tons per acre in terms of dry soil. The actual sludge or mud washed from the same areas during this single rain, ranged from 9.65 to 14.89 tons per acre. The run-off ranged from 43 to 50 percent of the total rainfall of 1.72 inches.

Bad Practices

Most of the cultivated crops in the blackland region of Texas have the crop rows up and down the slopes, and the evils of this practice were thus readily apparent.

The value of oats as a means of vegetative control of soil erosion was indicated by the fact that land having a crop of oats on a 4-percent slope, incurred soil losses ranging from only 0.01 ton to 0.2 ton per acre of dry soil. The run-off from this oat field ranged from as low as 0.4 percent to 3.34 percent of the total rainfall of 1.72 inches.

[1] In cooperation with the Texas Agricultural Experiment Station.

Land having a cover of Bermuda grass on a 4-percent slope, sustained a soil loss of only 0.02 ton per acre, dry weight, while the run-off was 1.33 percent.

Comparison Drawn

On April 2, other areas, with slopes varying from 4 to 6 percent, received a rainfall of 1.09 inches, most of which fell within a period of 15 minutes. A field strip-cropped to oats and land bedded for cotton, incurred a soil loss of 0.48 ton per acre, dry weight. An adjoining area, having rows bedded for cotton up and down the slope, sustained a soil loss of 10.66 tons per acre. The actual weight of sludge or mud washed from this field was 14.2 tons per acre. In other words, strip-cropping was more than 22 times as effective in preventing soil erosion as the normal practice for the region.

No Added Expense

In addition to this remarkable contrast, attention is called to the fact that very little, if any, extra expense is required to follow the practice of strip-cropping. All that is required is to have alternate strips of feed crops (oats, sudan, red-top cane) on contour, which means that the crop strips are laid out across the slopes somewhat similar to terrace lines. The strips ordinarily may vary from 75 to 100 feet in width.

For the Texas blackland region, winter oats are considered to be one of the most effective erosion-control crops because of the fact that the land is protected during the greater part of the year and especially during the periods when most of the rainfall is normally incurred.

It will be many years before it is physically possible to terrace all of the land in Texas that is adaptable to this type of protection against erosion. It is, however, easily within the means of practically every farmer to practice strip-cropping. This will often prove to be a good substitute until such time as terracing is achieved. Indeed, where slopes are not too steep, strip-cropping is a practice which many believe might be continued independently.

FREE SOIL FROM A NEIGHBOR'S ORCHARD

By Harry E. Reddick

Regional Director, California Project

One barranca—Californian for gully—robbed a landowner of more soil in 41 years than he could have hauled away in a truck if he had spent every day carrying his ranch down to the river and dumping it in.

Soil erosion is a menace in California second only to the indifference of the people whose handling of the land most certainly will decide the agricultural future of the State.

Erosion Common

As a rule, the citrus fruit grower is pretty smart. He has to be if he is to pay a dividend on land that he has purchased at city-lot prices, and on which he has a large overhead in taxes, fertilizers, pest control, and water. But if you think erosion isn't commonplace in California fruit orchards, take a drive through any of the foothill sections after a winter storm. It is erosion that causes those deposits of soil and sand across the highways in many places. Much of that soil came from around the tree roots in somebody's orchard. Erosion caused those roots to be exposed along the upper edge of those older groves; and erosion brought that fine sharp sand down that has covered the bud unions on those young trees, which will have to be replanted if they are to stand a 50-50 chance against gummosis. The greater part of whatever value your land has, in an agricultural sense, lies in those few inches of top soil. And yet there are growers who will say there is no erosion problem in citrus orchards, when trees in the upper ends of their own holdings appear to be standing on the tip ends of their roots, while in the lower slopes the trees begin to fork before they are out of the ground 6 inches.

"Blessings" from Above

What else does erosion do? One orchard was filled in to a depth of 4 feet this year, and another young orchard has had to be replanted three times on account of soil washing down from land above. This free soil that you get from your careless neighbor up above is usually like most free things—pretty much without value. The water that carries it down takes into solution most of the available plant food that the soil originally contained, and leaves the sterile sharp sand behind. Besides that, the introduction of noxious weeds, such as morning glory, devil grass, and puncture vine, as well as root diseases may often be credited to free, but unwanted, soil that came from someone's else land.

What can citrus growers do about erosion in their orchards? On all ground having a slope of 1½ percent or more, depending upon the type of soil involved, the thing to do is plant, cultivate, and irrigate on the contour. Stationary water is never the cause of erosion, and the whole plan of erosion control in southern California is based upon attempts to prevent water from running, because it is running water that carries away the soil. When an orchard is contoured the same thing is done, in a practical sense, that would be accomplished if it were possible to pick up a plot of land and drag a straight edge across it. If an orchard is contoured, on slopes ranging from 4 to 14 percent, and bench terraced with permanently vegetated risers on the land steeper than that, there are but two other safeguards necessary to combat erosion. The main thing is a good cover crop, planted early enough to be able to hold the soil when the first rain comes, and left growing long enough to hold the last rain in the spring; and second, provisions made to carry the excess storm waters safely into the barrancas or watercourses that have been controlled or stabilized by vegetation and soil-saving dams.

Two Ways to Meet Problem

If the orchard is one of the older square-set groves that has already suffered severely from erosion, there are two possible courses to follow: One is to protect what soil there is left, and the second is to haul back the soil which has been carried away and place it about the trees where it came from originally.

Cover crops are undoubtedly the most easily applied, as well as among the most effective erosion preventives known for square-set orchards on sloping ground—if they are planted early enough and left long enough. As stated before, they should be started by irrigation in order that they may be sufficiently mature to protect and hold the soil when the first fall rain comes, and they should be left in place until there is little or no chance of a late rain catching the land unprotected.

There are two common objections to this method of cover crop management; one is that the plants absorb too much precious moisture from the soil, if left growing too long; and the other is that the mature, hardened stems and stalks of the cover crop lock up too much nitrogen and keep it from being available for plant food in the following growing season. Mowing the cover crop before it reaches maturity, and letting the litter lie, will go a long way toward saving the moisture and nitrogen, and at the same time the roots will be there when needed to hold the soil. While soil moisture certainly is a thing to guard in southern California, we can always fall back on irrigation; but soil once gone is usually gone forever.

Slowing the Flow of Water

Shortening the irrigation runs so that a smaller head of water will carry through is a good thing to be considered in square-set orchards, and often the direction of the irrigating furrows can be changed so that they will have a more gradual flow line, thus cutting down the possibility of erosion from irrigation. There are many cases where a complete change from the old gravity system to that of the overhead sprinkling type would be justified by the saving of the soil due to the elimination of long, or steep, irrigation furrows.

The idea of hauling rich agricultural soil from place to place will sound fantastic to many, although for a long time the Chinese have made a practice of completely exchanging the top soils of cultivated plots, and it is being done here in California by progressive growers. The manager of one of the largest lemon ranches in the State recently said that he was never at loss for a place to use his teams in the winter months, because he could always set them to hauling the dirt back up the hill. Another grower equipped himself with a tractor-loading device that enabled him to haul over a hundred loads of soil per day. In realining his irrigation runs he changed them from 4½ percent to around 1½ percent, and although the work has scarcely been completed, he is already convinced that it was profitable investment of time and money.

Halting the Raindrop's Travels

A discussion of soil conservation methods in California without considering water conservation is impossible, because they are both of great importance, and because the control of one automatically implies at least a partial control of the other. The water conservationist seeks to induce the rains to enter the soil, instead of running off the land, in order that the water will remain available for irrigation during the dry months; the soil conservationist attempts to do exactly the same thing, but for a different reason—to keep it from eroding the land as it runs away. "Keep the raindrop where it falls" could well be the slogan for both, and whether the result is accomplished by contour planting, dikes, terraces, cover crops, or soil saving dams, the California agriculturist who practices erosion control, is of necessity killing two birds with one stone. After all, good water is of small value to the grower without good soil to put it on.

Limestone Distributed to Cooperators

Tests show that most of the soil in the Big Creek area, Missouri, has a lime requirement of from 1 to 3 tons per acre. This fact indicates that it is impossible to grow crops having a high lime requirement, such as alfalfa and sweet clover, without applying lime. It has been found that much better crops of red clover may be grown on this land with the use of limestone, and even timothy responds favorably to a sweet soil.

More than 15,000 cubic yards of limestone have been crushed for distribution to farms in this area, in the interest of increasing crop yields and assisting in the control of erosion.

Nine-year-old orange orchard, planted and cultivated on the contour, suffered no damage in storm of December 31, 1933, although planted on a steep hillside.

TERRACING PRACTICES VARY ACCORDING TO CONDITIONS

By T. B. Chambers

Assistant Chief Engineer, Soil Conservation Service

Terraces are being constructed on most of the 40 demonstrational projects, in an area extending from Wisconsin to south Georgia and from New Jersey to the Texas Panhandle. Within this vast territory are encountered a variety of conditions in soils, climate, cultural practices and topography. A wide range of treatments in design and construction are required. Because of the fact that visitors to projects in different sections of the country are often struck with apparent inconsistencies in the terracing program, an outline of conditions and practices is here presented.

The Soil Conservation Service generally bases its terracing procedure upon the recommendations of the several colleges of agriculture. These recommendations are the outgrowth of experience obtained by agricultural workers in adapting practices to local conditions. Naturally, the size, shape, grade and spacing of terraces varies widely throughout this large area and any attempt to attain a standardization would be out of the question. It happens, however, that the conditions upon which terrace designs must be based are so nearly similar in three major subdivisions of this area, and the purposes for which terraces are constructed are so nearly identical within each subdivision, that the three subdivisions will be considered as units. I speak of (1) the Southeastern Piedmont and adjacent upper coastal plains, (2) the Middle West, including the prairie States immediately west of the Mississippi River, and (3) all that portion of the great plains lying east of the Rocky Mountains and west of a north and south line running approximately through the center of Kansas.

We will consider the three subdivisions in the order named:

Piedmont and Adjacent Coastal Plains

The topography is quite similar throughout the entire scope of this region, consisting of short steep slopes and narrow valleys. The slopes are generally eroded, often gullied and present a very rough uneven surface on which terraces are needed. Fields are small, steep and of nonuniform shape. The annual rainfall totals from 40 to 56 inches in frequent downpours which are often of high intensity. The topsoil is characterized by light sandy loams and clays. Cultural practices throughout the region are uniform and generally make use of walking-plows on row crops laid out along the contour. A summation of these conditions shows a highly erodible soil, steep slopes and large annual rainfall with periods of high intensity.

When such land is to be terraced, let us first consider a principle substantiated by experiments on the Soil Erosion Experiment Stations of the Department of Agriculture: That, for many soil types and within the limits of terrace spacing, soil-loss increases and water-loss decreases as the length of slope increases. Or, to state conversely, the shorter the slope the more water loss and less soil loss.

The problem then is to take the water away from the fields in the shortest possible time (moisture conservation is seldom a problem in this section) with minimum soil loss.

To satisfy the conditions and problem, we have small terraces constructed on relatively steep grades, placed at short horizontal intervals and with large water channels extending into the more impervious and less erodible subsoil. By close spacing, the water loss is increased and soil loss decreased. At the same time the total accumulation of water behind a terrace is small and is further reduced by accelerated run-off due to maximum grade along the terrace. The water channel is of maximum size and the ridge is incidental to construction of the channel. Percolation through the ridge is minimized by lowering the channel into the subsoil. The steep narrow ride is not an obstacle to cultivation since small equipment is used and cultivation is on the contour. Terraces in this subdivision are generally 12 to 15 inches high after settlement. The ridges are 12 to 18 feet wide at the base and are constructed on variable grades ranging from 1 to 5 inches fall per 100 feet. The horizontal intervals are such that a mile of terrace protects approximately 9 acres.

Midwest and Eastern Plains

This region is characterized by long undulating slopes ranging in gradient from 3 to 8 percent over a majority of the area with occasional steeper slopes

occurring in some sections. Soils are predominantly silts and silt loams, highly erodible when not protected by vegetation. Annual precipitation is less than in the Piedmont subdivision and ranges from 20 to 40 inches. Periods of high intensity occur frequently in the summer months and this fact is one of the controlling factors in designing the terrace system. Further complicating the matter is the almost universal practice of straight-row cultivation with large machinery, which necessitates crossing terraces.

The problem, then, is the two-fold one of moisture and soil conservation, calling for terraces constructed on flat grades and spaced at relatively wide horizontal intervals. The terraces are unusually long due to large field units, and because of this and a rainfall of high intensity there is a maximum run-off requiring an exceptionally high terrace ridge. The water channel is not of such importance as it is in the Piedmont, since absorption is desirable. Consequently, the terrace ridge is constructed with nearly equal amounts of soil taken from the upper and the lower sides.

The result is a broad, high terrace ranging in width from 18 to 30 feet and in height from 18 to 24 inches, constructed on a variable grade of 0 to 3 inches fall per 100 feet (allowing normal precipitation to be absorbed and peak flows to be discharged) by use of large-blade or elevating graders. The length of some of these terraces is unusually great, extending from one-half mile to a mile. The area protected by a mile of terrace averages 20 acres.

Western Great Plains

The topography here is characterized by very uniform, unbroken, wide, sweeping slopes whose gradients seldom exceed 4 to 6 percent. Rainfall is less than in the other two areas, running from 16 to 20 inches per annum, with relatively low intensities. Predominating soils are light sandy or silt loams, and due to the low annual precipitation wind erosion is a much greater problem than water erosion. Field units are large, often comprising 640 acres or more and the prevailing farming practice is cultivation in long straight rows with power-drawn equipment.

The problem is primarily one of moisture conservation. Terraces are necessarily wide-spaced, of medium height and broad base, and constructed level with the ends closed to prevent discharge. The water channel is not of great importance and, as in the second subdivision cited, the terrace is constructed from both the upper and the lower sides.

These terraces on a steep hillside were made with an especially constructed tractor-drawn gang plow and were finished with a grader. Trees will be planted in these terraced channels.

The resulting level terrace is ordinarily from 18 to 24 feet wide at the base and from 15 to 18 inches in height depending on rainfall intensity and absorptive capacity of the soil. The spacing is such that an average mile of terraces protects 22 acres of land. Heavy-blade graders and elevating graders have proved economical for use here.

It is realized that exceptions to these conditions and practices occur in all three subdivisions. The intention here has been to give an outline of the predominant conditions and prevailing practices, in the interest of a clearer conception of the terracing problems involved. The cultural practices referred to are those prevailing among farmers in the various regions. The Soil Conservation Service is everywhere attempting to encourage the use of contour cultivation.

Recognizing the importance of native plants in erosion control has led to the starting of a survey and the collection of information regarding the distribution of plant life within the Gila River project. Data and specimens are being assembled in the field herbarium located at project headquarters in Safford, Ariz. Visitors to the project are being invited to make use of this valuable material.

EROSION CONTROL IN THE WHEAT LANDS OF THE PACIFIC NORTHWEST

By W. A. Rockie

Pullman, Wash., Project

The initial large-scale effort at erosion control in the Pacific Northwest was begun early in 1934. The first demonstration area selected consists of a small watershed unit of the famous Palouse wheat lands drained by the extreme headwaters of the South Fork of the Palouse River. The watershed, which has an area of 151 square miles, drains westward. The Washington-Idaho State line approximately halves the area. Moscow, in Latah County, Idaho, is near the center of the watershed; Pullman in Whitman County, Wash., is at its foot. The State College of Washington and the University of Idaho are located at Pullman and Moscow, respectively.

The area as a whole has the characteristic Palouse topography; it is like no other region and must be seen to be appreciated. An aerial view of this topography shows on a much larger scale conditions closely resembling sand dunes; but the soil consists of extremely fine silt and clay instead of sand. The windward, or southwesterly, slopes usually have a 20 to 40 percent grade as compared with the leeward slopes of 35 to 60 percent. The aerial photographs show strikingly the lack of glaring clay hilltops in the mountain headwater area, and the terrible frequence of such hilltops in the Palouse topography. This topography is a striking example of geological erosion, on which our civilization is now superimposing a man-made process of soil wastage.

Tree-Like Spread

The south Palouse drainage is of dendritic pattern and mature age. On every portion of the area natural surface drainage is adequate. The South Fork proper drains about half of the watershed, while Paradise Creek, Missouri Flat Creek, and Dry Fork (tributaries which enter the South Fork at Pullman) drain the other half.

On all the area except the mountain slopes and foothills the soil has been classified as Palouse silt loam. This soil as classified includes several rather distinct phases or conditions. The soil on the mountain headwaters consists of residual granitic material with some admixture of wind-blown dust.

The Palouse erosion control project is almost entirely in cultivation. Only at the extreme headwaters on the slopes of the Moscow Mountains and several associated granitic hills is cultivation of the land not complete. These mountainous headwaters are more or less covered by stands of coniferous timber.

Slopes Originally Well Covered

The land was originally "Palouse prairie" with pine and fir forests covering only the extreme headwaters. The Palouse prairie grasslands consisted of a very luxuriant growth of several species of bunchgrass with which were associated some areas of shrubs and, less frequently, trees. The more exposed southwesterly slopes were covered with luxuriant pure grass stands while the more protected slopes had denser stands with frequent shrubs and occasional trees.

Agricultural settlement of the Palouse region began less than 60 years ago. The first cultivation was done in the valley bottoms; later the lower slopes were broken, and finally the upper slopes and hilltops. In the early years of cultivation, every part of each slope yielded generously, but practically all of the hilltops and many of the upper slopes have had all of the topsoil washed away—either out onto the bottom lands or downstream to the river or ocean bed.

Organic Material Removed

During recent decades, agricultural practices, under the wheat-summer-fallow system of farming, have left this land utterly unprotected against the elements for about 12 months out of each 24. The landowners and the farm operators generally, in their efforts to control weeds and to secure the greatest crop yields from the land, have practically "dry-cleaned" the soil. Repeated tillage, fallowing, and burning have so completely destroyed the structure and body of this soil and so seriously decreased the organic matter content that today 10 to 15 percent of the area of the average farm is truly submarginal because of the resultant erosion.

The program of erosion control simply involves some common sense principles of safe use of the land.

Each farm unit is carefully studied as a separate and individual problem. Vegetation forms the foundation for control work in this area. Where it is deemed necessary, mechanical controls also are established.

The clay hilltops and the steepest slopes are seeded to grasses or to grass-legume mixtures, or they are planted to adapted kinds of trees. These are the areas from which the heaviest soil and water losses have occurred; such retirement from cultivation results in almost complete stabilization of the particular areas retired.

Rotation Planned

Much of the cultivated land must continue to produce crops. It is planned that the soil on these areas shall be maintained and rebuilt by means of scientifically safe crop rotations. These rotations must include the practice of green manuring the land. In effect such rotations render the soil more spongelike, mellow, absorptive, and productive. This is the first step toward a constructive, permanent agriculture.

The lowlands, draws, and stream bottoms make up a relatively minor percentage of the land area, but their protection is an important phase of erosion control. Most of the draws are to be kept in permanent plant cover. Where it proves necessary, temporary dams built flush with the bed of the drainway are installed to prevent further damage and destruction.

Revenue from Retired Land

On all of these lands that are being removed from annual tillage, special attention is being given to obtaining the largest possible income from the retired acres. Such income may be in the form of pasture, hay, or seed from the forage seedings, or may consist of posts, fuel, nuts, or fruits from tree plantings. Since these products are obtained from acres that were unprofitably farmed under the old plan, any returns from them add to the net income of the farmer.

Under the agricultural practices which have prevailed, the Palouse lands are deteriorating rapidly, farmers' incomes are becoming steadily less, community prosperity is in turn being affected, and slowly but surely the decline will grip the entire region.

The Palouse area can, should, and must be changed from a one-crop checkerboard of wheat and fallow fields to a region of great diversification in farming and stockraising. In other words, the change must be from a temporary, destructive, short-sighted mining of the land to a sound, permanent, constructive farming system.

Aerial mosaic of south Palouse watershed, Whitman County, Wash., and Latah County, Idaho, by the Soil Conservation Service with the cooperation of the Forty-first Division Aviation, Washington National Guard.

WISCONSIN LAW ENCOURAGES REFORESTATION

An act which is causing widespread interest among conservationists was recently passed by the State Legislature of Wisconsin. It is directed toward gaining the cooperation of farmers in reforestation and aforestation. It is expected to be of important assistance in the general program of erosion control. Here it is—

AN ACT

To repeal subsection (4) of section 77.02 and to create subsection 70.11 of the statutes, relating to the exemption from taxation of farm wood-lots and sloped lands, and providing a penalty

The people of the State of Wisconsin, represented in senate and assembly, do enact as follows:

SECTION 1. Subsection (4) of section 77.02 of the statutes is repealed.

SEC. 2. A new subsection is added to section 70.11 of the statues to read:

"(70.11) (40) (*a*) Any wood lot or wood lots forming an integral, even though detached, part of any improved and regularly operated farm and not exceeding one fifth of the total area of such farm, if the same is enclosed with a legal fence sufficient to keep out horses, cattle, sheep, hogs or other grazing animals.

"(*b*) In addition to the land described in paragraph (*a*), any portion of a regularly operated farm, the slopes of which are of a gradient of more than thirty percent, if the same is enclosed with a fence consisting of not less than three barbed wires and the owner refrains from cultivating, or mowing such portion, grazing any type of livestock thereon and from burning over such land or takes reasonable precautions to prevent such burning; and if the owner makes a reasonable effort to reforest such portion or to revegetate the same with grass or shrubs such as will prevent erosion or excessive run-off.

"(*c*) To obtain such exemption, and a proportionate reduction in the assessed valuation of the entire farm, the owner shall file a sketch and an affidavit with the town clerk setting forth the accurate dimensions of the wood lot described in paragraph (*a*) or of the sloped portion described in paragraph (*b*), in metes and bounds, and showing as to the wood lot that such property does not include any improved lands and is fully stocked with growing trees, has been fenced as herein provided, and certifying that the land will not be pastured; and showing as to the sloped portion described in paragraph (*b*) the percentage of gradient of the slopes thereof, that such portion has been fenced as herein provided, and will not be mowed, burned or grazed as herein provided, and certifying that the owner will make a reasonable effort to reforest such land or revegetate same with grass or shrubs such as will prevent erosion or excessive run-off. Upon the filing of such affidavit the assessor shall make an examination of such wood lot or sloped portion to verify the claims made in such affidavit and determine whether such wood lot or portion is entitled to exemption under this subsection. Upon his certification to this effect, such wood lot or sloped portion shall be exempt from taxation and the assessment of the farm shall be proportionately reduced. For his services in making such examination, the assessor shall be paid a fee of two dollars by the owner of such property. Any assessor who shall maliciously and wilfully refuse to allow an exemption of lands qualifying for exemption under this subsection or who shall fail to proportionately reduce the assessment of the entire farm or verify the claims made in the affidavit, shall be liable to the penalties prescribed in section 348.264.

"(*d*) The exemption from taxation of the lands described in paragraphs (*a*) and (*b*) shall continue as long as such lands are used exclusively for the purposes specified in said paragraphs and comply with the conditions thereof. A list of all lands exempted under this subsection shall be prepared each year by the town clerk, stating the name of the owner, location and approximate area of the land exempted, and such list shall be posted for the annual town meeting in the town hall. When such exempted lands cease to be so used or no longer comply with all of the requirements of this subsection, the exemption from taxation shall terminate and such lands shall be returned to the tax roll.

"(*e*) The board of review shall annually review all exemptions under this subsection and shall hear and pass upon the complaints of any owner or citizen who may appear before said board in regard to exemptions applied for or granted hereunder."

SEC. 3. This act shall take effect upon passage and publication.

A Review—DEBT BURDEN AND SOIL CONSERVATION

Part of the second report of the Iowa State Planning Board Ames, Iowa, April 1935, pages 27–28–29. Based on the economic and sociological survey made by Iowa State College, Ames, Iowa, in cooperation with the University of Missouri, on farms located within the Big Creek watershed of the Soil Conservation Service, Bethany, Mo.

A heavy debt burden tends to stimulate heavy cropping, particularly at a time of falling price level. The conspicuous increase in the corn acreage throughout Iowa and Missouri during 1930 and 1932 undoubtedly reflects, in part, this increased debt pressure.

The survey shows that the percentage of crop land in the Big Creek watershed in corn increased from 32 percent on farms practically clear of debt to 43 percent on farms with a mortgage of $51 or more per acre. The percentage of farm land in crops also increased from 51 percent to 72 percent with increasing size of mortgage per acre.

The conclusion is, among other things, that the effectiveness of any soil conservation program could be substantially increased by relieving the soil from financial pressure created by excessive mortgage indebtedness.—C. REED HILL, Salt Creek Project, Zanesville, Ohio.

U. S. GOVERNMENT PRINTING OFFICE: 1935

NEW PROGRAM FINDS STAFF READY

Announcement of plans for establishment of 93 new demonstration projects as the result of allocation of Works Relief funds by the President found headquarters staff and regional offices thoroughly prepared.

These plans have been in the making for many months. They are an outgrowth of a free sifting of information, opinion, and experience and represent a composite of judgment of those upon whom the responsibility falls for carrying them into effect.

Early in August a mimeographed manual, Procedure for Starting a New Project, was placed in the hands of key persons in the field. It outlines conveniently general policies, advances helpful suggestions pertaining to the setting up of the new erosion-control areas. It treats of staff, organization, and budgeting, deals in some detail with steps involved in agronomic, engineering, and forestry phases of the new undertakings. While intended as a continual reference work, ample allowance is made for problems and conditions peculiar to the several localities and for the individual capacity and initiative of regional directors and specialists.

H. H. Bennett, Chief of the Service, expects the enlarged program to be cohesive, coordinate, and progressive in development as a result of the sound groundwork that has been laid. He sees in the proved ability and loyalty of his field workers assurance of success. He calls upon each member of the staff in Washington and throughout the country to keep faith with the mandate handed to the Service to lead the way to the better husbanding of the Nation's soils.

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HENRY A. WALLACE
Secretary of Agriculture

H. H. BENNETT
Chief, Soil Conservation Service

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IMPRESSIONS OF THE THIRD INTERNATIONAL SOIL SCIENCE CONGRESS

By W. C. Lowdermilk[1]

Significant advances in pedology, or soil science, were noted at the Third International Congress of Soil Science. The congress brought together in England more than 400 delegates from 40 countries at the ancient University of Oxford for its sessions from July 30 to August 7. Following the congress, an excursion was made by a number of the delegates, from August 8 to 23, to examine and discuss soil conditions in England, Wales, and Scotland. Out of a wide range of subjects presented at plenary and division meetings, papers describing the hitherto little known soils of Africa and reporting advances in microbiology and soil formation were outstanding in interest.

This congress was the third general meeting of the International Society of Soil Science, which has grown to large proportions and importance within the past decade. It constituted a joint session of the six commissions of the society, each of which is devoted to a special phase of pedology. They are: Soil physics; soil chemistry; soil microbiology; soil fertility; soil genesis; morphology, and cartography; and application of soil science to land amelioration.

It is the practice for the commissions to hold interim meetings which serve to bring together pedologists with specialized interests more often than do the congresses. It will be recalled that the first congress was held at Washington, D. C., in 1927, and the second in Moscow in 1930.

The congress was opened at the Rhodes House, Oxford, by the president, Sir J. E. Russell, who is also the director of the renowned Rothamsted experimental station. After the address of welcome by the vice chancellor of the University of Oxford, the president delivered his address in which he reviewed advances in the science of pedology. A report on the work of the International Society of Soil Science since the second congress was given by Dr. D. J. Hissink, and on the publications of the society by the honorary editor, Prof. Dr. F. Schucht.

Plan of Procedure

The procedure of the congress was well designed for maximum benefit to members and delegates. Mornings were devoted to plenary sessions of each of the six commissions in turn, at which papers of general interest were read and discussed. Afternoons were given over to separate or joint sessions of the commissions and subcommissions. Papers delivered before plenary and commission sessions were printed in advance and made available for study before the

(*Continued on page 15*)

[1] An official delegate of the United States to the International Congress of Soil Science. Dr. Lowdermilk is Associate Chief of the Soil Conservation Service.

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VOLUNTARY ASSOCIATIONS GET UNDER WAY

Functioning in Alamance, Richmond, and Union Counties, N. C., are the first voluntary soil conservation associations to be formed under provisions of the Report of the Secretary's Committee on Soil Conservation. They are at the forefront of many similar organizations through which the erosion control program is to be administered during the next 2 years.

Group Responsibility

In this report made to Secretary Wallace the necessity of dealing with groups rather than individuals was emphasized. "We believe", it was stated, "that the Federal Government cannot manage erosion-control operations efficiently with hundreds of thousands of individual farmers, but that local group responsibility will have to be obtained through the organization of cooperative control associations or governmental agencies, which should be permanent in character and legally empowered to own and dispose of real estate, to lay assessments on their members, and otherwise to obtain compliance in a complete erosion-control program on the area owned or controlled by the members of the association. Nevertheless, we recognize that during the organization period of the Soil Conservation Service, and especially for the next few months, it may be necessary for a few E. C. W. projects to be undertaken outside of demonstration areas and on the lands of farmers not members of such legally constituted associations. However, even in the emergency period, the Department should at least require that such projects be handled through voluntary soil conservation associations."

In furtherance of this policy, it was recommended that on and after July 1, 1937, and sooner wherever feasible, all erosion-control work on private lands, including new demonstration projects, be undertaken only through legally constituted soil conservation associations or governmental agencies. Until that date, new E. C. W. erosion-control projects on private lands outside of demonstration areas, if not handled through legally constituted associations, will be undertaken only through voluntary associations, and then subject to the specific approval of the Secretary of Agriculture.

Three Units

Voluntary associations may be organized on the basis of an E. C. W. camp, a small watershed or a county, according to G. L. Crawford, acting head of Cooperative Relations. In each instance a local soil conservation committee, composed of the association's board of directors and representatives of the Soil Conservation Service and the Extension Service, will develop local land-use policies and farm management principles. This program must bear the approval of the State advisory committee.

Committees will also be set up to promote membership and the signing of contracts, to study farm management practices as related to erosion control, to cooperate with forestry officials and those interested in the preservation of wild life, to purchase heavy machinery or other needed materials or equipment, to keep accounts and records and collect fees, to foster educational work and to perform other essential duties.

PASTURES BROUGHT BACK

Here are shown contour pasture furrows being constructed on a farm in the Plum Creek drainage area of Nebraska.

They were built in March with a plow and Corsicana terracer on a native pasture as part of a plan to restore overgrazed pastures in this area by contouring and pasture management.

These particular furrows were planted to a grass mixture immediately, and the area fenced to protect from grazing. As this is written, the new grass is becoming established and will soon be seeding the space between the furrows.

About 380 acres of pastures in the area will be furrowed this year.

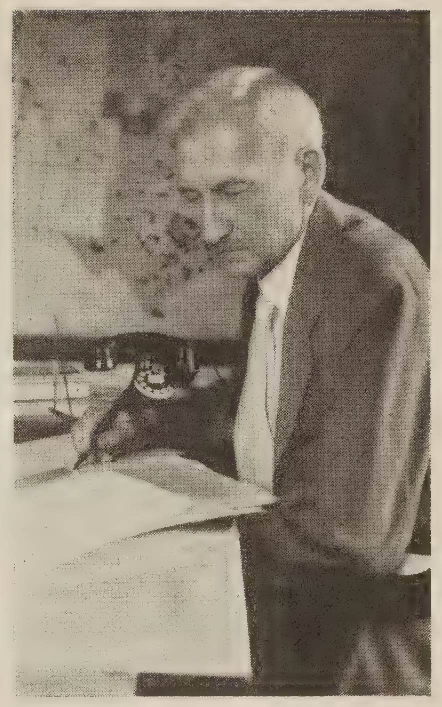
DR. CURTIS F. MARBUT

In Appreciation

The passing of Dr. Curtis F. Marbut, Chief of the Division of Soil Survey of the Bureau of Chemistry and Soils, is felt keenly by the Soil Conservation Service.

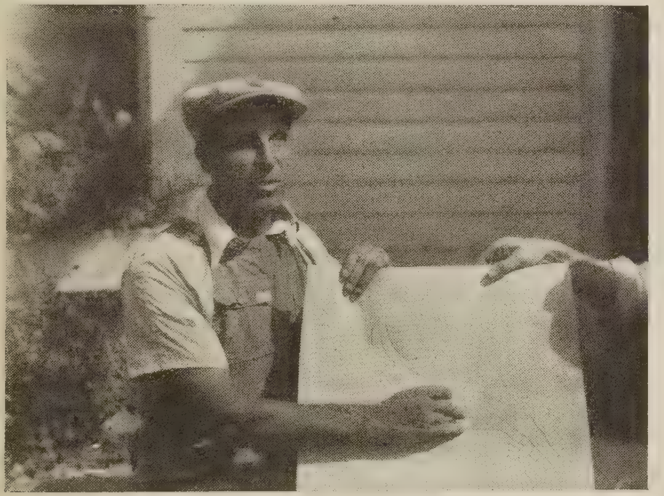
He was the leader of soil science in the United States and one of the outstanding pioneers in that science in the world. The present concept of soils in the United States has been molded under his guidance. He enriched and molded the field of thought appertaining to soil science by his own fundamental contributions and by pointing out to others the direction for their thoughts and investigations. It has been due to his leadership that soil science has become one of the foremost fields for research. It has been due to his basic and fundamental contributions to soil knowledge that soil utilization and soil conservation are recognized today as dominant in the life of the Nation.

Many in the Soil Conservation Service have been personally associated with Dr. Marbut, some closely, some but infrequently, and others only by the ties of leadership in thought or action. But all who have been associated with him in any capacity feel that Fortune bestowed a signal honor upon each who was so privileged.—THE STAFF.



"One of the outstanding pioneers"

BRAILLE MAP MADE FOR BLIND MAN



"Seeing is believing", say farmers of the Bear-Deer Creek Watershed near Spring Valley, Minn., when they see the effectiveness of strip cropping, terracing, gully fills, and other measures in checking soil losses caused by erosion. Stewart Warren, however, believes without seeing. For 15 years he has carried on his farm operations in darkness.

His farm of 91 acres is divided by a creek which wanders pleasantly through the meadow until rains convert it into a destroying torrent. In the last 20 years a deep gully has eaten into the land above the meadow and a series of finger gullies have been reaching into the grain fields. Last year it was impossible to drive a wagon into the corn field and the corn had to be carried in bushel baskets across the gulch.

Mr. and Mrs. Warren, well aware of the damage erosion was doing to their land, were anxious to cooperate in checking it.

Nail Holes Indicate Lines

In order that the blind owner might better understand the contours and strip planting of his farm, a crude Braille map was drawn from the aerial picture to the scale of 1 inch to 150 feet. The lines of the contours were indicated by small nail holes close together while the boundary and fence lines were indicated by perforations farther apart. With this map as a guide, Mr. Warren is able to read his contour strips more readily than the average farmer.

The farm has been reclaimed by terracing, strip cropping, and structures built to prevent reopening of the main gully which was sloped down and incorporated into the permanent meadow. The finger gullies have been filled and the terraces with sodded outlets now protect the land from above. Three acres of the steepest hillside have been planted to trees.

Nursery work in cooperation with State establishments has been started in Nebraska, Kansas, Texas, Alabama, and New York.

''THEY CAME THROUGH''—SURVEY SHOWS WHERE DROUGHT MET MOST RESISTANCE

By D. A. Savage [1]

Hardy native grasses constitute our main reliance in the task of covering anew millions of acres in the Great Plains region. We look to such plants as buffalo grass (*Buchloë dactyloides* (Nutt.) Engelm) and blue grama (*Bouteloua gracilis* (H. B. K.) Lag.) to check blowing by wind and washing by flood and to restore pasture value to lands grown unproductive under continuous cultivation.

Buffalo and blue grama have long been considered immune to fatal injury by drought. This conclusion is refuted by studies made in 1934 by the Fort Hays, Kans., Branch Experiment Station, which revealed a large percentage killed in the disastrous season of 1933–34.

In May and June this year, the studies were extended to other stations in the Plains. A detailed ecological survey was made in the western part of the central Great Plains to determine the native grasses which survived, the weeds which lived through and the percentage of ground cover supplied by each species of vegetation.

This work was conducted by the nurseries of the Soil Conservation Service in cooperation with the Divisions of Forage Crops and Diseases and Dry Land Agriculture of the Bureau of Plant Industry, and the State experiment stations.

Method of Charting

A total of 643 meter quadrats, representatively located, were charted with pantographs to show the ground cover of all native grasses and other perennial or turf-forming vegetation on closely grazed pastures, moderately grazed pastures and ungrazed areas, on all of the major types of soil prevailing in the vicinity of Hays, Colby, Garden City, and Tribune, Kans.; Woodward, Okla.; Dalhart, Tex.; Akron, Colo.; and North Platte, Nebr.

Each chart was reduced to an area one twenty-fifth that of a square meter by a lineal ratio of 5 to 1. The charts are now being measured with planimeters to determine the actual percentage of ground cover occupied by each kind of vegetation. Considerable time will be required to complete this work and to compile the data. It will be impossible to announce definite results until these calculations are made. Meanwhile, this preliminary report of general observations made at each station and while traveling between stations will serve to indicate the present condition of the pastures.

Buffalo Grass on Heavy Soils

Buffalo grass was the principal component of the native grasses on the heavy soils throughout the region. The basal cover of this grass was equaled by that of blue grama on the semiheavy soils and was exceeded by the latter on the semisandy soils. Only a few scattering plants of buffalo grass were found on the very sandy soils. Blue grama appeared to be adapted to a much wider range of soil conditions. It occurred in varying amounts on every texture of soil, from extremely heavy to very sandy. Even on the latter soil it often represented a considerable percentage of the vegetation.

Western wheat grass (*Agropyron Smithii* Rydb.) and wire grass (*Aristida purpurea* Nutt.) were interspersed with buffalo grass and blue grama on the heavier types of soil. The sandy land grasses consisted of an association of several or all of the following grasses: Blue grama, side-oats grama (*Bouteloua curtipendula* (Michx.) Torr.), little bluestem (*Andropogon scoparius* Michx.), big bluestem (*Andropogon furcatus* Muhl.), switch grass (*Panicum virgatum* L.), sand reed-grass (*Calamovilfa longifolia* (Hook) Scribn.), wire grass, sand dropseed (*Sporobolus cryptandrus* (Torr.) A. Gray), needle grass (*Stipa comata* Trin. and Rupr.), blow-out grass (*Redfieldia flexuosa* (Thurb.) Vasey), and several other grasses of lesser importance.

Grazing an Important Factor

Grazing not only aggravated the injury by drought but appeared to have materially affected the relative amounts of the different grasses present. Although close grazing was probably detrimental to all of the grasses, it was less injurious to blue grama and still

[1] This is a preliminary report by the assistant agronomist, Division of Forage Crops, Bureau of Plant Industry, Hays, Kans., Experiment Station.

less to buffalo grass than to any of the others. The ground cover of buffalo grass often exceeded that of blue grama by a wider ratio on the closely grazed areas and moderately grazed areas than on the ungrazed areas.

Many plants of all native grasses throughout the region were killed by a disastrous combination of intense heat, severe drought, close grazing, and soil blowing. The surviving ground cover varied from zero to about 60 percent, with an average of about 30 percent for Woodward, Okla., and North Platte, Nebr., and about 15 percent for most other localities. The damage varied about as much within a locality as it did between localities and seemed to be directly and positively correlated with the severity of drought, intensity of grazing and proximity to cultivated fields. The heaviest damage was noted on small, closely grazed and severely trampled pastures which had been badly scarified by dust-laden winds from adjacent cultivated fields. The percentage of the bluestems and other taller grasses killed by the drought was greater than that of the predominating short grasses.

Normal Stands Await Rains

On most pastures the grass, though thin, was rather uniformly distributed and appeared capable of regaining normal stands in one season of average and timely rainfall. Other pastures in many localities, particularly the small ones in the vicinity of Dalhart, Tex., and Dodge City and Garden City, Kans., may require three seasons to recover completely. Even the larger pastures did not escape serious injury, although they were not so badly affected by soil blowing. This indicated that soil blowing was, by no means, the only factor which contributed to the death of the plants.

Practically all pastures in the region were heavily infested with a vigorous growth of annual and perennial weeds. This is a condition which seldom occurs to any appreciable extent on typical short-grass grazing land and will, no doubt, materially retard recovery. Many of the more severely damaged pastures contained numerous seedlings of buffalo grass and blue grama, which will hasten recovery if they are not destroyed by grazing, weed competition, or further drought. Short periods of hot winds and dry weather may kill a large number of these seedlings before they become well established.

All quadrats were permanently located so that they could be rechartered in subsequent years to determine the rate and duration of recovery and the succession of growth under different conditions.

Fence Lines Gone

Although water erosion is the main problem on the Plum Creek area in Nebraska, this picture reflects the unusual condition during the past spring, following the 1934 drought.

The drought favored very little vegetation and what did grow was harvested for feed. This left the soil an easy prey to blowing.

For days at a time the wind whipped the dried-out, pulverized particles across the hilltops into fence rows or clumps of Russian thistles.

The fence between the Pelley and Beckwith farms, shown herewith, was covered with silt to a depth of 4 inches. The farmers of this section are now as much concerned with the problem of wind erosion as they are with that of water erosion.

Summary

The immunity of buffalo grass and blue grama to drought has been refuted by studies made at the Hays, Kans., Experiment Station in 1933–34 and in the western part of the Central Great Plains during the summer of 1935.

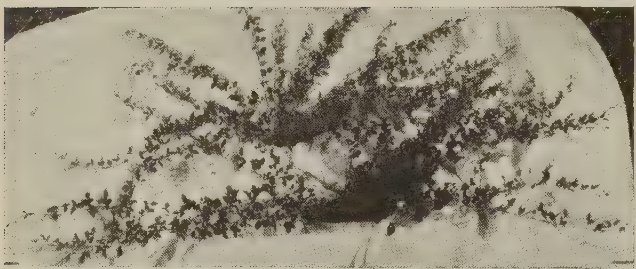
Several hundred quadrat studies taken under various conditions have revealed that drought damage to the grasses seemed directly and positively correlated with the severity of drought, intensity of grazing and proximity of cultivated fields. Heaviest damage was noted on small, closely grazed pastures badly scarified by dust-laden winds.

The surviving ground cover averaged approximately 30 percent for Woodward, Okla., and North Platte, Nebr., and about 15 percent for Hays, Colby, Garden City, and Tribune, Kans.; Dalhart, Tex., and Akron, Colo.

LEGIONS OF LESPEDEZ

By Paul Tabor

Sandy Creek Project, Athens, Ga.



Lespedeza procumbens, a native perennial legume

During the little-known second Spanish period of Florida history, near the year 1800, there was a governor named Lespedez. His political and military deeds were so completely buried with him, that even the name is difficult to find in most American libraries. Despite such historical oblivion, his fame lives on because a botanist, Michaux, gave the name "lespedeza" to a group of purple-flowered native American legumes having one seed per pod.

Other kinds of lespedezas have been found in Japan, China, Korea, and Australia. Some of them have been brought into the Southeastern United States both by accident and by planned introduction, and a few have been amazingly successful. Uncounted billions of these plants are now serving as privates in the battle against soil erosion on both agricultural and waste land. These legions of Lespedez richly deserve a high place in the history of soil conservation.

Native Kinds Perennial

All the native American lespedezas are perennials. There are more than 10 species with upright stems and 2 with creeping or decumbent stems. The stems are renewed from the heavy underground crowns each spring like those of sweet clover and alfalfa.

Seed production is rather heavy but practically all the seed is too hard for good germination. This prevents dense natural stands. Perhaps the use of scarified seed will overcome this difficulty and make it possible for these native plants to take over abandoned or retired fields more quickly and completely. The two species with creeping stems show enough promise at Athens, Ga. to be tested next season as erosion preventing crops.

The introduced or immigrant species of lespedeza include both perennials and annuals. The most promising perennial is *Lespedeza sericea* from China. It has considerable resemblance to alfalfa except that the stems are larger and harder.

Cut Early for Good Hay

A good quality hay can be made by cutting before the stems get woody. A practical biennial or perennial hay crop has been badly needed in the South. Such a crop would make the type of farming there more permanent, would automatically provide more feed for livestock and would do much in soil conservation. *Lespedeza sericea* may fill this need well enough to be widely accepted. It is being extensively introduced by the soil conservation projects of the South. The young plants develop slowly during the first season. To provide a more adequate cover the first year a mixture of annual and *Lespedeza sericea* seed have been sown on the Sandy Creek Project.

Lespedeza bicolor is larger and more woody than *Lespedeza sericea*. It may have a place as an erosion-resisting shrub. Its seed, like those of all other perennial lespedezas, must be scarified if a good germination is to be obtained.

Once Regarded as Weed

The annual species are the most interesting and important. In their native home in Japan and Korea they are regarded as harmless weeds. They are used in Japan for the control of erosion. The common lespedeza found its way into middle Georgia prior to 1846 and during the next 20 years spread widely throughout the South without invitation or assistance from mankind. For more than 40 years it was regarded as a harmless weed. Opinion has gradually changed during the past 45 years until it is now considered a valuable crop. The change started in the 80's in the lower Mississippi drainage basin when it was first grown as a hay crop. In this region the genus name

lespedeza came into common use and has gradually supplanted the popular names, Japan clover and wild clover. It is still known as shamrock in middle Georgia counties where it was first found in this country.

Common lespedeza has several characteristics that make it peculiarly adapted to southeastern United States. It grows well on poor soil, seeds profusely, germinates well, and the young plants endure low temperatures for short periods. Frequently at Athens, Ga., germination has occurred by mid-February and the young plants have endured two or more cold spells with minimum temperatures of about 20° F. Such an early start gives lespedeza a decided advantage over later species of summer plants.

Lespedeza Needs Moisture

The most important limitations of the common lespedeza are its great need for moisture during the early periods of growth and during seeding, and its susceptibility to nematodes. The high moisture requirements, especially during spring, can scarcely be met on thirsty clays or on hill soils where spring droughts are severe. The Athens region is rather dry in the spring for annual lespedeza. The weather man has been generous during the past 2 years, however, and lespedeza is rapidly making gains.

Common lespedeza is highly variable, indicating a complex heredity which is an advantage in securing a relatively wide adaptation to soils and climate. It also furnishes good material for selecting superior strains. The Tennessee Experiment Station has taken advantage of this opportunity and selected a large, fine-stemmed kind known as "Tennessee 76." A larger, coarser kind has been introduced from Japan and named "Kobe." Both have greater possibilities for hay than the common kind if the soil is suitable for high yield.

Korean lespedeza differs enough from the common group to be classed as a different species. It is earlier in growth and seeding and consequently better adapted further north in the United States than the common group of annual lespedezas. The practical southern limit for Korean lespedeza is in the northern half of Georgia and its northern limit in the lower edge of the Corn Belt. In the section between the Cotton and Corn Belts it has contributed greatly to better agriculture and promises to do more in the future.

Firm Seed Bed Required

The seed of annual lespedezas are sown in late winter or early spring, at the rate of 25 to 50 pounds per acre. A firm seed bed is needed to insure sufficient moisture in the root zone of the young plants. Broadcast seeding on grain is common. The seeds need to be covered lightly to prevent heavy rains floating them into depressions and giving an uneven distribution. Best results can be expected by using a weeder or a spiketooth harrow both before and after seeding.

Tall weeds in lespedeza fields are discouraged by slipping high enough with a mower to barely miss the lespedeza tops.

When once well established on a field, annual lespedezas usually reseed naturally. By plowing so the soil is loosened without inverting, leaving the seed near enough the surface to germinate the next season, it is possible to maintain lespedeza in a winter grain-lespedeza rotation for several years.

The lespedezas are now so important in soil conservation through the Southeast and have such possibilities for future development, that our appreciation of them must enchance.

Some ambitious tenant plowed up a pasture on this farm. As a result the top 6 to 8 inches of soil was washed away, leaving the infertile subsoil exposed. The washed portion of the field supports only weeds and a few feeble stems of native grass. The native grass sod above is in good condition, and still intact, though subjected to the same degree of wind and water erosion. This washed-off spot will be reseeded this fall to a mixture of brome, meadow fescue, and orchard grass, and fenced to protect it from livestock until it becomes resodded.

WIND EROSION ON THE SUMMER-FALLOWED WHEATLANDS OF THE WEST

By A. L. Hafenrichter and H. M. Wanser

Pullman, Wash., Project

Once soil begins to drift, the process of wind erosion may go forward unceasingly, like a cancerous growth. It literally defies man's efforts to curb it with physical barriers and extends the boundaries of affected areas with reckless abandon.

Erosion by water affects land directly and progresses with predictable sureness. Erosion by wind has little respect for slope gradients, direction of slope, or adjacent lands lying in any direction from the primary affected area. Wind erosion not only ruins the soil in the field or range where drifting began but increases drift susceptibility on additional areas, sometimes of great expanse, wherever the coarser wind-blown particles come to rest. Run-off water obeys certain fundamental laws with respect to direction of flow, but winds behave with uncertainty.

The wide areas of drifting soil in western America today are a dismal reminder of incorrect land practices. Susceptibility varies greatly with different soil types. It is probable, however, that thousands upon thousands of acres of prairie land were placed under cultivation which were ecologically unsuited for the sustained production of cash crops under intensive and continued cultivation. This becomes particularly evident when drought conditions prevail. Many agencies with a shortsighted motive undertook to move hundreds of sturdy farmers to the frontiers of the West who were accustomed to managing soil only under humid conditions. Thousands of abandoned homesteads, drifted fields, buried fences and inundated roads are monuments to these prodigal practices.

Farms were abandoned in the East for more profitable new land in the West. Water erosion played a part in this movement, only to have the buffeting effect of wind erosion again force abandonment in many instances.

Farming Practices Cause Drift

The story of the causes of drifting soil is essentially no different from that of a water-eroded and gullied slope. When the land was first broken "out of the sod" it did not drift despite intense wind and occasional mild drought years. After some years of crop production, it was found necessary to introduce the practice of summer-fallowing to sustain crop yields, and with it stubble burning became a common practice. Summer-fallowing rapidly depleted the organic matter content of the soil and, though it probably escaped notice, changes in the soil structure resulted.

Slight movement of soil took place, but since there were no perceptible accumulations this received little attention. The loss of the finer soil particles to the atmosphere during the stages of incipient drifting caused no great concern. Under these conditions it is little wonder that the very means by which the soil resisted wind action were rapidly reduced. How striking is the analogy to accelerated water erosion! At the critical point in changed soil structure unfavorable climatic conditions such as "drought years" telescoped the effects that were destined to be realized sooner or later and ruin resulted in a short time. A torrential rain on a denuded slope with impoverished soil does no greater damage than a strong wind acting on mismanaged soil when aided by a deficient moisture supply.

Careless Management

The removal of the grass cover from prairie soils, intensive cash cropping, the burning of stubble, and the practice of summer-fallowing are not alone responsible for drifted fields. The factor is often overlooked that these lands were managed carelessly by people accustomed only to handling soil under humid conditions. Tillage implements were used that left the surface in a finely pulverized condition; as the soil structure changed, this became even more critical in point of resisting wind action. The all-important cloddy surface well mixed with organic debris was not present; when plows, disks, harrows, floats, and drag chains were used, there was a disintegrated dusty mulch at the mercy of even slight wind movement. After serious drifting began, a desirable surface was difficult if not almost impossible to obtain. The damage had been done.

Another striking feature of areas subject to soil drifting is that they invariably bear unmistakable signs of accelerated run-off, especially in regions having summer rainfall. The evidences of accelerated run-off may appear relatively inconsequential but they are unmistakable to the experienced observer. This is surely to be expected, for these soils have nothing that obviates water losses. The essential point is that even relatively minor losses are of tremendous significance.

Control Takes Time

The control of wind erosion must be based on the same fundamentals of soil management as the control of water erosion, for the basic causes are the same even though the agency is different. The essential difference between the two is that the control of soil drifting is a longer, harder, more trying task. To build the soil of wind eroded areas back toward the condition in which nature gave it to us is nothing short of an Herculean task. The very agencies that should be employed to attain permanent results are difficult to use.

The important lesson that must be drawn from long-time experience in wind erosion areas is that there is a very sharp line of demarcation between prevention and control. There must be no equivocation on this point in the summer-fallow country. It is easier, more practical and more economical to prevent wind erosion than to control it.

Proper Tillage Practices

Wind erosion can be prevented in summer-fallow areas by the early use of proper and timely tillage practices. The most important and effective of these are the use of disc plows for the plowing operation, infrequent and timely weeding with rod weeders or weeders that bring clods to the surface, the incorporation of organic matter into the surface, the introduction of grass in a rotation, and the seeding donw of critical blow "spots." Duck-foot cultivators are particularly useful in the northern plains. These methods must be adopted not only where incipient drifting is noted, but where climatic and edaphic conditions make wind erosion likely.

The one-way disc plow, when used in place of the moldboard plow, has proved itself wherever it has been tried. A frequent criticism is voiced against this change since it is believed by some that the disc

Virgin soil held in place by yucca plants. This shows about 4 feet of the surrounding soil lost. It is in an overgrazed pasture area.

plow increases drifting. A careful examination of such cases invariably revealed the fact that the plowing was untimely or the disc was used also for weeding. The plowing operation must be done at a time when a pronounced cloddy condition can be obtained. This requires a careful observation of soil moisture conditions. Even with the disc plow, stubble must be worked into the soil and not burned for any reason.

Time, frequency, and manner of weeding the summer-fallow are as important as manner of plowing. A cloddy surface, well mixed with organic residues, must be maintained. The rod weeder used only frequently enough to control weeds is very effective. It leaves clods and residues on the surface and buries the finer particles. Weeding must never be done until the clods have "set" after the plowing operation. Other weeding implements that attain the same result as rod weeders may be used but discs, harrows and "slickers" must never be used.

Permanent Cover Required

In the prevention program, every critical area of soil or topography that tends to drift on a field or farm should be seeded to a permanent grass cover. These are the areas that are the portals of entry for wind erosion.

Along with this a rotation should be introduced that will maintain the organic matter. For many ecological and management reasons, grass is probably the only possibility. The frequency with which it should be grown on a field varies with local conditions, but 10 to 20 percent of the farm should be in grass. This means a considerable adjustment in the wheat-fallow districts when tractors are the chief source of power.

Without question it involves adjustments in land valuation and size of farm; hence, prevention of wind erosion becomes more than an individual problem.

The control of wind erosion, once the soil has drifted, is no simple procedure and involves even greater adjustments than prevention. Among the first points to be decided are what can be used as emergency methods, what must be done to attain permanent control and which lands must be dedicated to a new use. The methods that have been described as useful in preventing drift have merely served to stave off the day of reckoning in areas where the soil has actually drifted. Hence, these may be regarded as emergency measures. To tillage practices may be added ridging, furrowing, strip-cropping, and application of manure. All of these have proved to be emergency expedients of temporary character in the wheat summer-fallow sections. Strip-cropping is also done as a permanent technique in many places.

Circumventing the Wind

Control of wind erosion requires the adoption of more stringent methods than those used for prevention and this is not always easy. Here exacting determination of degrees of drift could be used to considerable advantage provided the classifications are sufficiently elastic to compensate for the recognized idiosyncrasies of wind action. It must be determined which areas must be given over to grazing instead of agriculture to adequately protect them and reduce their effect on adjoining areas. The remaining areas must be treated by a rotation with grass where possible, so that each field is in grass 15 to 20 percent of the time. The difficulty in inaugurating such a program is that a new land-use system must be adopted.

This involves a larger acreage, to attain an economic farm unit and the inclusion of livestock in the farming system. It will be recognized that both changes have far-reaching effects on the agriculture of the Nation; some easily attained, others difficult to accomplish without considerable adjustment. The change must come in a rational land use, commodity adjustment, and erosion-preventing program. For sections that have no grass that lends itself to farm practice, feed crops may be utilized.

In addition to what has been pointed out as necessary to control actively drifting soil, it is always assumed that the most efficient tillage practices will be continued on the land under cultivation. When run-off can be retarded and water conserved, there is no justification for not doing so. In parts of the West receiving little summer precipitation and having sandy loam soils this can largely be taken care of without artificial mechanical controls.

Last spring several "old-timers" in one drift area of the Northwest watched a news reel of wind erosion taking place in another part of the country. They failed to be amazed at the sensational nature of the damage that was being wrought. Afterward they remarked that land in their area drifted like that 15 to 20 years ago until the "poor farmers" were eliminated and then settled down to a persistent conservative type of blowing. Land management in drift areas is an art as well as a profession.

Another class of soil drifting is that for which there is no cure. The only rational solution for the use of such lands is to recognize defeat and set them aside for grazing. These lands must be carefully determined both for the present and for the future. No single agency can accomplish this end by itself. It will require a combination of efforts.

Prevention of wind erosion is a national necessity but control is not certain unless stringent methods are used. Any control other than that inherent in the soil is questionable as a permanent measure.

NEW NURSERIES ESTABLISHED

Nineteen new nurseries will be established by the Soil Conservation Service to meet the pressing demand for trees, shrubs, and grass seed for use on erosion control demonstration projects, according to Charles R. Enlow, acting head of the Division of Nurseries.

This brings the number of nurseries to 83. The coming year will see the production of 600,000,000 trees and shrubs and the collection of 1,000,000 pounds of grass seed not commercially available. The work will go forward in 38 States, on nurseries ranging in in size from 2 to 800 acres.

Special attention is being given to the collection of seed from 25 species of native grasses.

Fifteen of the nurseries will provide materials for the 545 C. C. C. camps under the direction of the Service.

DAMS IMPOUND STATE'S WATER AGAINST TIME OF DROUGHT

By L. C. Tschudy

"The breadbasket of the world"—that's what they called North Dakota in the days when it led the States in wheat production and boasted the leading primary markets for wheat and flax.

But our farmers were not satisfied. They sought to cram still more bushels into the bulging granaries. They went so far as to vote funds for draining sloughs and lakes as they reached out for more and more land to cultivate.

Four years of drought came. The water table dropped to depths where wells no longer functioned. Flowing streams dried up and cattle died of thirst. Water had to be shipped in by train. Winter ice was no longer available. Waterfowl could not find water. City water supplies showed an alarming shortage.

North Dakotans, therefore, rued their loss of water stores and eagerly welcomed the Government's proposed conservation of natural resources. Having no national forests or parks within their boundaries, they found themselves outside the scope of the original Emergency Conservation program. They took an appeal to Washington, convinced the administration of the necessity of holding back the annual spring run-off so as to restore the ground water table to its normal elevation. In May 1933 Emergency Conservation Work to be carried on by the Civilian Conservation Corps in North Dakota was authorized.

Seven Camps Initiate Work

Seven main camps were established in June of that year with F. E. Cobb, State forester, as director of conservation work and A. D. McKinnon as State technician. These camps were administered by the State director and supervised by the United States Forest Service. They were located in North Dakota in the summer and transferred to other States for the winter. During the time these camps were located in North Dakota, 133 dams and three diversion canals were constructed.

The water conservation program was immediately popular and in a short time over 2,700 applications for dams of various sizes were on file in the central office.

Cooperstown Dam, constructed of rubble masonry; length, 50 feet; height, 9 feet; pond area, 45 acres.

When the 1934 program was authorized more permanent structures were requested, and as a result cement was permitted to be purchased. Six C. C. C. camps were set up in May 1934. This number was increased to 14 in the latter part of July, when additional drought-relief camps were established.

A Year's Accomplishment

The different types of structures and the number of each constructed in 1934 follows: 14 rubble masonry overflow, 5 earth fill with rubble masonry spillway, 62 earth fill with mechanical spillway, 21 earth fill with natural spillway, and 3 treated timber crib, making a total of 105 dams constructed in 1934. In addition to this, permanent masonry spillways were built in 60 of the 1933 projects. The total amount of work accomplished in the third period (May to October 1934) was placing 279,439 cubic yards of earth fill, 13,443 cubic yards of rubble masonry, 5,620 cubic yards of rock tee, 68,268 square yards of rock rip-rap, 532,000 board feet of timber and sheet piling, and 2,114 lineal feet of tile pipe.

The water that these dams will store for use in North Dakota would cover 115,607 acres of land to an average depth of 1 foot.

Current Program Under S. C. S.

During the winter of 1934, when the camps had moved to other States, a special appropriation was

(Continued on page 14)

ALL THIS STARTED FROM THE TRICKLE FROM A ROOF

By Leon J. Sisk

Sandy Creek Project, Athens, Ga.

Providence Cave, like some Gargantuan monster, has devoured everything that stood in its path.

A country road has been changed several times, and now a huge gully is approaching the present road from either side. Several homes, a schoolhouse, a church, a cemetery, even the barn from which it had its humble beginning were not spared. All went into its maw to satisfy an insatiable craving. It was, indeed, "hungry as the grave."

The Building of a Barn

Back in 1855 a barn was built on the Patterson farm, out from Lumpkin, in Stewart County, Ga. It was probably a good barn. I have no way of knowing, for it has long since been gone.

I can picture this barn, though—big, solid, and proud as a bank. It was the depository of wealth garnered from the soil. Probably there was a huge loft containing winter feed for the stock. Beneath was stored grain, corn, wheat. At night the silence was broken by the moving of cattle and the stamping of horses. By day it echoed to the shouts of children playing in the haymow or searching for hidden nests of hens.

There it stood, secure and snug. Soon summer had fled, and a hint of frost was in the air. The harvest was over and the barn filled to bursting.

Evenings found the family inside the house grouped about a great open fire. Cider and big red apples were on a table and youngsters were busily popping corn.

The winter rains had begun and outside the rain fell in a steady, typical winter drizzle. And underneath the eaves of the barn a course was established for Georgia's biggest gully.

No Control of Run-Off

If Farmer Patterson had controlled the run-off from the barn when the gully was first beginning, much damage could have been averted. Had terraces been constructed in the vicinity of the barn, had the path taken by the run-off been sown to close growing vegetation, all this desolation could have been averted. But Farmer Patterson did none of these things.

From this small beginning the gully has progressed until today there exists an immense system of gullies, called Providence Cave. This system, with its many "fingers" covers from 50 to 75 acres of land. The

A scene of devastation that is characteristic of the spectacular tragedy wrought by erosion in parts of Stewart County, Ga.

gullies vary in length and depth. Some are from 100 to 200 feet deep and from 100 to 200 yards in width.

Many other gullies are in this same vicinity, some of them approaching Providence Cave in size. Seventy thousand acres of land in Stewart County, once high-grade farm land, have been destroyed by uncontrolled erosion. At one time this section was composed of land as fertile as could be found in Stewart County. Now, by actual planimeter measurements, 32 per cent of 15,360 acres of land in the vicinity of the Cave is unfit for cultivation, being composed of rough, gullied land.

Much of the land is operated by tenants and no attempt has ever been made to stabilize the gully. It has steadily proceeded, increasing in size with each rain. Nothing has impeded its progress.

Not only houses, burial grounds, roads, and the actual ground on which it fed and thrived suffered, but acres upon acres of fertile land were covered with worthless material washed from the gullies, rendering these unfit for cultivation.

Even at this date it can be stabilized, but land that was at one time worth $5 to $20 an acre can never be restored to its former usefulness.

The land where Providence Cave is located could be in valuable timber if proper care had been given at the right time. As conditions are today, timber falls into the caves as they advance. Soil from the caves has dammed up streams below and formed lakes and useless sand areas.

The tragedy is that this, the largest gully in Georgia, which has caused thousands of dollars damage, which would cost thousands more to stabilize, could have been prevented.

ILLINOIS FARM ADVISERS TOUR PROJECT

Ninety-two farm advisers (county extension agents), representing 100 of the 102 counties in Illinois, toured the Sangamon River demonstration area recently and saw with their own eyes what mechanical structures supported by vegetation will do to control erosion. The all-day tour was attended by approximately 200.

The trip was sponsored by the Soil Conservation Service in cooperation with the Illinois College of Agriculture, as part of the annual 3-day program for farm advisers at the university. Several agricultural college faculty members and other farm leaders in the State also were present.

Grasses Effective

The unusually fine growth of grasses and forage crops in the area this spring supplied plenty of evidence to the visitors of the power vegetation has in controlling erosion. Alfalfa, bluegrass, sweetclover, and lespedeza were doing a splendid job of holding the soil in place. One of the farm advisers remarked, "If we could cover the State with a good sod, we wouldn't need any erosion-control program."

But Illinois farmers must till the soil and they must grow corn. The farm advisers are well aware of this and showed special interest in the demonstrations of strip-cropping and contour farming—practices entirely new to most of them.

Interest in Gully Control

The gully dams attracted considerable attention, especially from the advisers of southern Illinois, where gullies are large and numerous. The beneficial effects of grass waterways were seen in several instances.

One example in particular warrants mention here. A livestock farmer, who owns 85 acres of rolling land, established sod in a deep gully when he bought the farm 9 years ago. Today the gully is completely filled. A soil profile taken from the waterway revealed that 42 inches of soil had been deposited in the gully in the

9 years. The profiles which demonstrated this condition impressed the visitors because they had the whole picture right before them—the eroded field, the grass waterway, the profiles and the farmer himself, who related the story.

At the terracing demonstration, which concluded the tour, the visitors had an opportunity to experience some of the difficulty often encountered in educating the farmer to the value of terraces.

Terraces Would Have Prevented This

The demonstration was held on the farm of W. G. McCullough, who owns a section of land and farms with heavy machinery. Last summer our field men agreed to seed alfalfa on a slope which was eroding badly. He did not want terraces. Soon after the alfalfa was seeded, the first week in August, a heavy rain fell and washed many gullies 6 to 10 inches deep and 1 to 3 feet wide. When Mr. McCullough saw what had happened he immediately asked for terraces and was well satisfied when they were built.

Then he wanted terraces built on the opposite slope so that he could sow more alfalfa. It was this terracing that was done as a demonstration for the tour. Before the terracing crews started work, Mr. McCullough stated to the group that he did not believe he could farm with the terraces because of the heavy machinery he used. But when the terraces were completed he said, "Those terraces are not so crooked but what I can farm with them, and I'll do that." He now has a small terracing outfit for his own use.

LARGE DEMAND FOR NATIVE SEED

Approximately 600,000[1] pounds of native grass seed has been requested by the various Soil Conservation Service projects in Kansas, Oklahoma, and Texas for 1936 plantings.

If this were timothy or Kentucky blue as it grows in the north and east, this quantity would not present a difficult problem, but acquiring this much native grass seed will be no mean accomplishment. The amount of seed finally obtained will depend not only upon the agility of the field men, but also upon the eccentricities of the weather.

When grasses form a sod so that each plant is in direct competition with several other plants, seed is formed only during the more favorable years. Getting seed from isolated plants is slow business.

To Specialize in Seed Production

Methods are being tried that appear to have considerable promise. We may find it necessary to plant areas for seed production alone. Such a method is going to be essential in producing some species.

Harvesting and cleaning the seed is another problem confronting us, even after we have found areas of good seed supplies.

[1] This figure has since risen to 800,000.

The average buyer of grass seed is practically unconscious of the fact that somewhere, buried among a mass of trashy material there are some kernels that represent the seed itself. Many assume that 100 so-called seed should represent 100 kernels. It seems that grass seed, even among our cultivated forms, is seldom so obliging.

Results of Study

For example, a study made this year on Dallis grass showed that on an average only 13.5 percent of these hulls had seed in them. Little bluestem, gathered from widely distributed areas of Kansas, Oklahoma, and Texas, produced seed in its glumes ranging from 5 percent up to 38 percent, averaging 14.1 percent for all samples collected. Blue grama averaged 53.1 percent of glumes enclosing caryopses. Switchgrass averaged 40 percent, Big bluestem 12 percent, and Western wheat 41 percent. Buffalo grass, having 2 to 5 spikelets per head or spike, averaged 1.4 seed per head.

Thus, our native grasses, though not as high in quality as a rule as most introduced grasses, are still high enough to be useful for planting purposes. If handled in the same way, they might be induced to produce seed of equal quality.—Excerpt from address by B. F. Kiltz, of the Stillwater, Okla., project, at the Sixth Southwest Soil and Water Conservation Conference, Tyler, Tex.

CLAY DRIFTS OF TULE LAKE SUMP

Sand dunes are a familiar feature of semiarid regions. Clay drifts, being less frequently seen, should prove of special interest. Such drifts have recently been observed on the leased lands of the Tule Lake bed just south of the Oregon-California State line in the Lower Klamath Basin.

The soil on Tule Lake Sump consists of 6 to 18 inches or more of dark, peaty silt loam or muck with 25 to 30 percent organic matter, underlain by a gray colloidal diatomaceous material of silty clay loam, which contains about 15 percent volatile matter. These lands were being cultivated in late April with a water table 18 to 36 inches from the surface, the moisture content of the muck amounting to 100 to 150 percent.

The lakebed lands south of the Government protecting dyke and outside of the bird reserve or sump proper are being leased in large units for extensive grain farming. The rank growth of grain straw, including combine lanes, is eliminated by annual light burning.

Particles Carried by Wind

In places, especially in the shallower peat near the edges of the sump, the plow reaches through the mantle of muck into the underlying chalky subsoil. This material when brought to the surface dries and shrinks, breaking down into small kernels a millimeter or less in diameter. Being lighter than sand, it is readily carried by the wind. Air movement of 15 to 30 miles per hour is not uncommon. Both peat and clay on the loose, cultivated land are easily picked up by the wind.

Small clay hummocks accumulate in numbers and sometimes attain depth equal to the height of stubble near the edge of the marsh.

In the cropped area the land surface is subsiding due to light burning, compacting with heavy tillage implements such as the caterpillar tractor, and extensive farming machinery, and the increased oxidation due to the lowering of the water table. Within the sump proper tules and related growths add several tons of organic material annually, increasing the difference in level and thus accelerating seepage.

It is suggested that over a long period of time it may be found expedient to move the sump or to rotate grain farming with wild game areas in long-time rotations.—W. L. Powers, Oregon Agricultural Experiment Station.

DAMS IMPOUND

(*Continued from page 11*)

granted for 6 survey crews. In all, 149 water-conservation projects were surveyed, designed, and planned for the 1935 construction season.

In April 1935 the water conservation work in North Dakota was transferred from the United States Forest Service to the Soil Conservation Service. Seven camps are now being occupied by the C. C. C. personnel in North Dakota, under the jurisdiction of the Soil Conservation Service. They are engaged in building small dams and some level terraces. These camps are located at Wishek, New England, Valley City, Park River, Mandan, Lakota, and Watford City. About 50 structures should be completed by October 1935.

SOILS SCIENCE

(*Continued from page 1*)

sessions. An opportunity was thus provided for prepared discussion. Papers were presented in English, German, or French.

Experiment Long Under Way

The agricultural experiment station of Rothamsted, which boasts of a field experiment in wheat growing that has run continuously for 90 years, held special interests for the delegates. It was fitting that the congress should have been held in England and in Oxford, as well. The University of Oxford was founded during the reign of Henry II of England (1154–89) nearly 800 years ago—Oxford, a famous seat of learning, the cradle of " causes ", the foster mother of literature, arts, and sciences. From Roger Bacon, 1214–92, the first great Oxford name in science to the present, Oxford has played a leading role in the development of the sciences. Although generally known for cultivation of the arts, the University authorities early recognized agriculture as a subject for higher learning in the foundation of the School of Rural Economy (Schola Economiae Rusticae) in 1796. This, with the School of Forestry founded in 1905, and the Imperial Institutes of Agricultural Engineering and Forestry, supplied traditions and interests favorable to the deliberations of a congress in soil science.

Appropriate Setting

Delegates were introduced into many features of the simple and venerable way of living of students at Oxford, by being lodged in student suites of rooms off the staircases of the colleges. The headquarters for the congress were located in the buildings of Wadham College. The famous towers of Oxford, and their bells and chimes, and the striking of Old Tom (the great bell of Christ Church College tower), created a beautiful setting for deliberations of a scientific congress.

It is impossible to notice within the limits of these impressions all important contributions made to pedology at the Congress. Only a few may be referred to briefly. The proceedings may be consulted with profit to specialists in the various fields of soil science.

Papers disclosed that soil mapping has rapidly received general attention and is contributing important services to agricultural developments in many countries. Soil mapping is now generally recognized as a necessary preliminary to agricultural developments. The soil map of Europe prepared by Professor Stremme and collaborators is a good example, as well as the preliminary soil maps of Africa.

Studies of Soil-Plant Relationships

Soil-plant-moisture relationships have received extensive study. Accordingly, the paper by Dr. R. K. Scofield proposing to express these relationships in thermodynamic terms and to measure the effectiveness of soil moisture for plants by means of a logarithmic scale—a pF scale—was received with special interest. Alike with the pH scale of soil acidity, the pF for moisture effectiveness represents a definite step in studies and measurements of soil-plant relationships.

In soil chemistry the recognition of calcium, sodium, magnesium, and hydrogen clays marks a distinct advance in an understanding of soil characteristics and in soil management for crop production. The work of Dr. Hissink on the Zuyder Zee reclamation is in point.

The field of soil biology is perhaps the most alluring in its appeal. The variety of organisms, their interrelations and activities in the nitrogen cycle is still as incompletely explored as the jungles of the upper Amazon Valley. The variation in numbers of bacteria from day to day, and even from hour to hour, leaves bacterial count of little significance. There has been disclosed in this bacterial jungle of the soil another law of " tooth and claw", protozoa, particularly amoeba, feeding upon bacteria and finding some more delectable than others. Antagonisms between certain strains of soil actinomycetes have been shown by G. Samuel; others intermingle. Cutler showed that relative efficiency of organisms may vary inversely as their numbers. Can this be also a case of overpopulation? And interestingly enough, nitrifying organisms go in tribes, whose allegiances are selective, to their appropriate leguminous plants. Three strains or tribes of *Bacillus radicicola*, otherwise indistinguishable, have been found by Thornton to affect the clover plant favorably, indifferently or unfavorably. The bacterial tribe most favorable to the clover plant prevails over its rivals, and opens up a field of possible directive control and improvement of pasture crops.

Plants Vary Requirements

Plant nutrition, estimation of plant foods within a soil, resembles an incompletely explored continent. While progress has been made, as reported by Mitscherlich, a number of baffling problems remain unsolved. Sir E. J. Russell forecasts the establishment of a scale of the amount of available plant food in the soil similar to the pH of acidity, and the pF of available water. Certain propensities of plants to vary their requirements may further complicate the problem. Papers on this phase of soil science will be read with renewed interest in this baffling problem.

Deterioration of the physical condition of soils in the loss of aggregate forming organic matter has been shown to account for susceptibility of soils to wind erosion. Attention to problems of soil-wastage by erosion by wind and by water was given more prominence at this Congress than hitherto. It became apparent that the interest in soil erosion varies pretty much with the intensity of this phenomenon in the homeland of the soil scientist. The degree of soil erosion and its menace to sustained productivity of soils is dependent in large measure upon the type of prevailing rainfall. Large continental areas which give rise to thunderstorms or convectional type of rainfall, suffer most acutely from erosion losses on cleared and cultivated fields. Thus, soil scientists of Africa, south and east, of India, and of China, understood more fully the problems of soil erosion and its control as reported by the writer for the United States.

The significance of the coming together of students of soil, its conservation and management, from the leading countries of the world is far-reaching. At such conferences problems affecting the welfare of humanity, rather than exclusively of a single national area, are discussed in the candor of scientific inquiry. A groundwork for international cooperation in the victualing, clothing, and provisioning of the peoples of the earth is being firmly laid in studies of the basic resource—the soil. Foundations are thus being laid for a structure of the future, whose dimensions and inclusiveness can now only be a subject of speculation.

PREVENTING BARNYARD GULLIES

By R. B. Hickok

Salt Creek Project, Zanesville, Ohio

In many of the hill sections of the country the farmsteads are often nestled against the side or at the foot of a steep slope. In former days abundant springs induced the pioneers to build on these picturesque sites where they were afforded protection from the winter winds and snows.

With the clearing of the forests, these slopes ceased to be protective and are now, in many cases, destroying the fertile land which lies below them. The denuded slopes shed the rain that falls upon them, and send it cascading down through the draws and gullies, in debris-laden streams, onto the farmsteads and outwash areas at their bottoms.

Farmyards Flooded

As a result, many farmyards have been swept clear of top soil and the continual tramping of livestock has left them beaten and barren. The buildings are often flooded by these run-off waters, which chisel their courses down through the richest cultivable land and pastures.

Ultimate control of these waters must extend to their source and will be brought about by the reestablishment of vegetative cover on the tops and sides of the hills and knobs.

In some instances diversion channels have been constructed across slopes to intercept run-off approaching farmsteads and carry it safely away to a vegetative outlet. These channels have the appearance of, and are constructed similarly to, a large terrace. They are usually large because great quantities of water must be handled. They are constructed with gentle grades to carry the water at low velocity to the outlet. It is expected that the channels and fill-banks will become sodded. In most cases the channels have been designed for maximum velocities of about 5 feet per second. The channels are seeded and temporarily fenced from livestock.

In some situations a small amount of protection of the diversion outlet is required. A few simple checks and spreaders may be installed to prevent damage while young trees and grasses are becoming established.

Controlling Gullies

If the farmsteads are located at some distance from the foot of the slope or situated on some of the gentler slopes, the damage is less general and is confined to gullying in the yards and lots. In such cases efforts have been made to control individual gullies by means of simple checks and fills to aid in reestablishing vegetation which has been trampled and washed out. Rock is available in most of the area and has been used extensively in gully control work. It has particularly proved its value in farmyard lots where tramping and close-cropping by livestock make conditions unfavorable to vigorous vegetative growth. The rock has been used to build "headers" at the heads of gullies and for rock and litter fills.

The "headers" are modified loose rock dams placed near the lip of the gully and filled from the crest of the dam back to the lip with loose rock and litter. Below the crest of the dam, loose rock and litter has been banked to form a cascade apron. The litter is considered essential in these structures as it will serve to catch and hold silt which will seal the structure and will make it possible for vegetation to become established among the rock. Effort is made to seed in and around these structures so that grasses will bind the structure in place and assure its success.

SUMMARY OF PROJECT PROGRAMS

A statistical report of Soil Conservation Service field work up to July 31—before the launching of the expanded program—showed 40 projects, 47,416,500 acres in projects, 1,563,557 acres in farms put under agreement, and 2,496,106 acres completed by the detailed erosion survey.

Other significant totals included 2,979 farms with treatment finished, 187,107 acres newly strip-cropped, 241,112 acres newly contour-tilled, and 371,021 acres upon which it was agreed to construct new terraces or do reterracing.

Up to this time 449,296 acres had been put under a system of proper rotation, and 24,611 acres had been newly contour-furrowed. More than 100,650 acres had been taken out of cultivation. The acreage of erosion-resisting crops had been increased under agreement by more than 182,690 and the acreage devoted to clean-tilled crops had been decreased by agreement to the extent of 104,045.

At the end of July 11,005 miles of terraces had been constructed, affording protection to 147,904 acres. More than 25,000 permanent terrace outlets had been constructed. An aggregate of 3,258,929 square yards of terrace outlets had been seeded and sodded. More than 204,000 temporary dams and more than 52,000 permanent dams had been constructed for the control of gullies.

Nearly 20,000,000 square yards of planting had been completed for the protection of stream banks. Gully planting amounted to 14,733 acres. Forestation work had resulted in the planting of more than 22,000 acres. Seed-collection tabulations showed 246,177 pounds for hardwoods, and 4,370 bushels for conifers. Fire hazards had been reduced on 21,088 acres.

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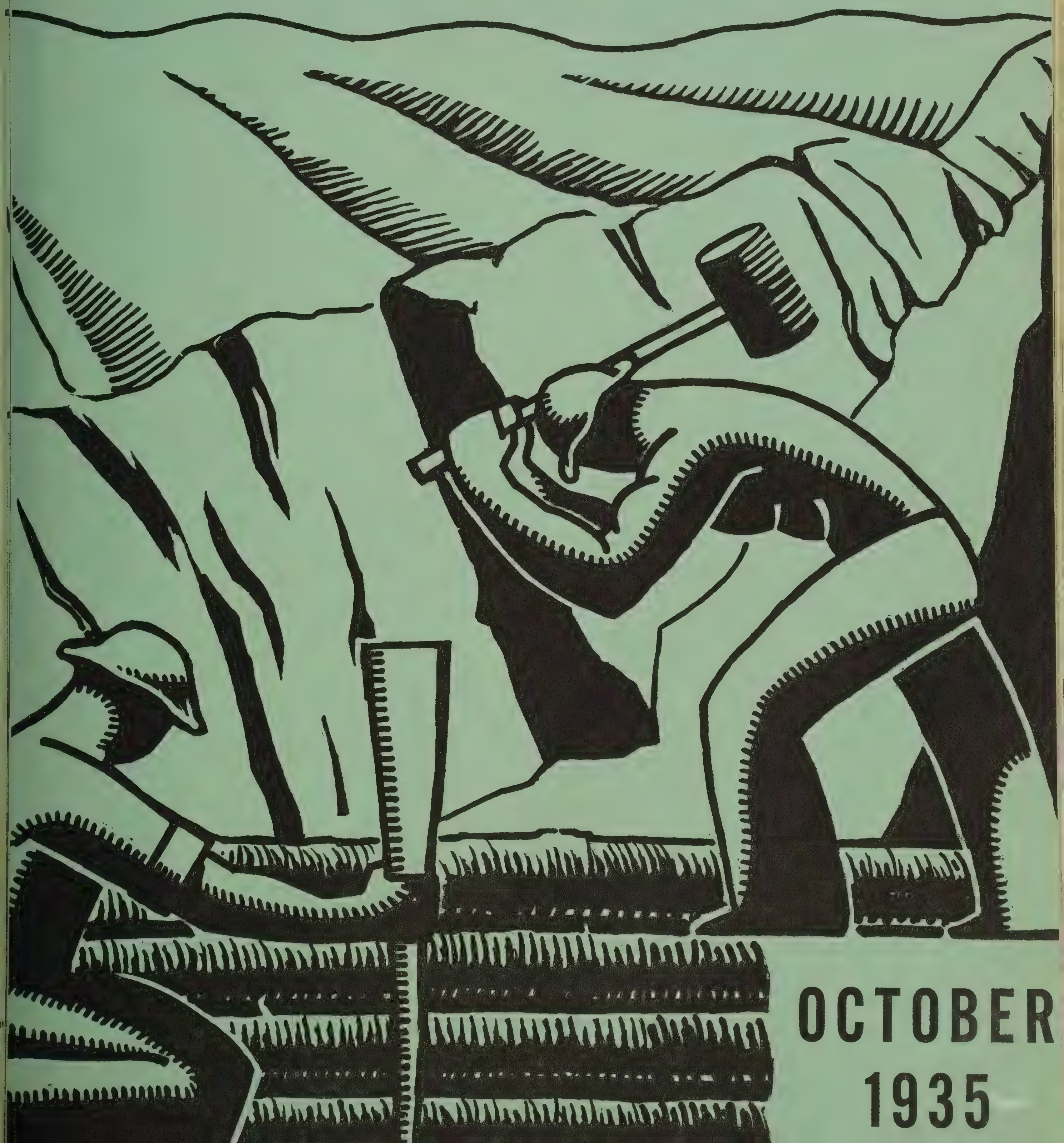

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SOIL CONSERVATION IN THE NAVAJO COUNTRY

By Charles W. Collier

For many years the American Southwest was pictured as a land of mining towns, mountains, and cactus-bearing deserts. Writers told of high adventure and of a continuous struggle to maintain law and order. Motion pictures added to the illusion with romantic stories of highwaymen and cowboys. Gradually in popular conception, the Southwest came to be regarded as a territory apart, where frontier mode was the rule rather than the exception.

Behind this exaggerated representation of life in the Southwest is a real story, more accurate, less fanciful, withal colorful. In the area now comprising the States of New Mexico and Arizona, great civilizations once lived and flourished. The evidence points to the existence of a highly scientific agriculture, accompanied by an advanced social culture.

Wooded mountain ranges and hills alternated with broad valleys of deep, rich soil, covered with an abundance of grasses, herbs, and grazing plants. Wild hay was there for the cutting. On the hills were great forests of pinon, juniper, and pine. Streams were lined with willows, cottonwoods, and other trees.

This was the Navajo country of a few centuries ago. This was the land the Spaniards found in their American explorations.

As It Is Now

Since 1867 the Navajo population has increased from about 8,000 to approximately 45,000, and from a few scattered herds of sheep the country is now attempting to support more than a million head of sheep and goats, plus considerable numbers of cattle and horses.

As the human and livestock populations grew, the blanket-weaving and wool-marketing activities of the people assumed proportions of a sizeable industry. In this the Navajos were encouraged by their white advisors, who had faith in the unfailing productivity of the land. But grass grew less and less vigorous, and the stand became more and more sparse. Soon gullies began to form around the too infrequent water holes and springs.

Once started, the erosion process proceeded rapidly.

The Oraibi wash is a typical example. Once a mild, narrow, and shallow stream, lined with small but productive cornfields, it has become an ugly, twisting gully

Typical panorama in the overgrazed country of the Southwest.

for its entire length of 80 miles, varying from 20 to 80 feet in depth. All of its tributaries are in a similar condition, adding to the destruction of farm lands and helping to carry enormous quantities of silt into the Colorado River.

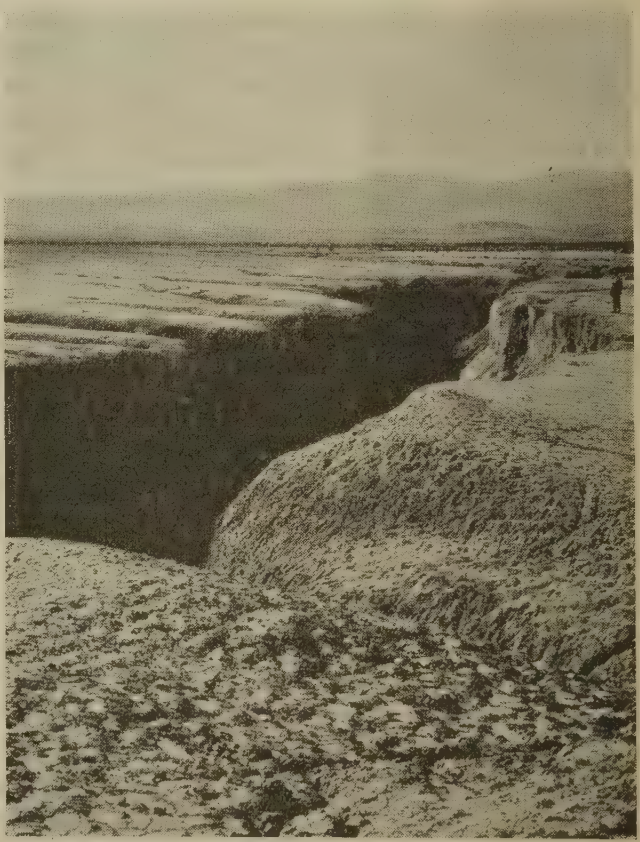
Overgrazing, the almost universal enemy of the Southwest, is responsible for the accelerated erosion typified by the Oraibi wash. Too many grazing animals, either concentrated in a small space or spread over a large area, reduce the normal stand of grass, weeds, and shrubs, and allow an unrestricted flow of water over the hillsides. Broad, grassy swales become networks of tiny gullies eating cancerlike in every direction and combining, in their downward paths, to form giant ravines, sapping the water formerly available for plant growth and destroying the power of even the richest soil to produce worthwhile vegetation.

Irrigation Becomes Impossible

That is what happened to the Navajo country. Cornfields and squash patches, formerly irrigated by simple methods of flood-water farming, are now neglected because the water courses have become wild and uncontrollable. Slopes and valleys that once produced abundant forage are now given over to worthless weeds and bare ground. The grazing cover has been destroyed to a large degree. The pinon, that valuable nut bearer whose great crops were one of the Navajos' chief income producers, is gradually disappearing because the goats destroy the seedlings and the mature trees are being consumed for fuel.

Recurrent droughts, which once held no terror for the Navajo, now deprive him of income and hasten depletion of the land. Where antelope, deer, and wild turkey were once abundant, overgrazing and unlimited hunting have depleted the stock. Reservoirs are being filled with silt and erosion debris, jeopardizing the effectiveness of irrigation systems.

Accelerated erosion is proceeding so rapidly, to the detriment of grazing, agriculture, forests, and irrigation works, as to threaten the existence of the Navajo people and the future of the entire region. The remedy lies in more careful use of the land, in the up-



Erosion's workings in the Southwest.

building and maintenance of proper soil conditions through the use of vegetation and grazing control, and in a general social readjustment to keep pace with the process of rehabilitation.

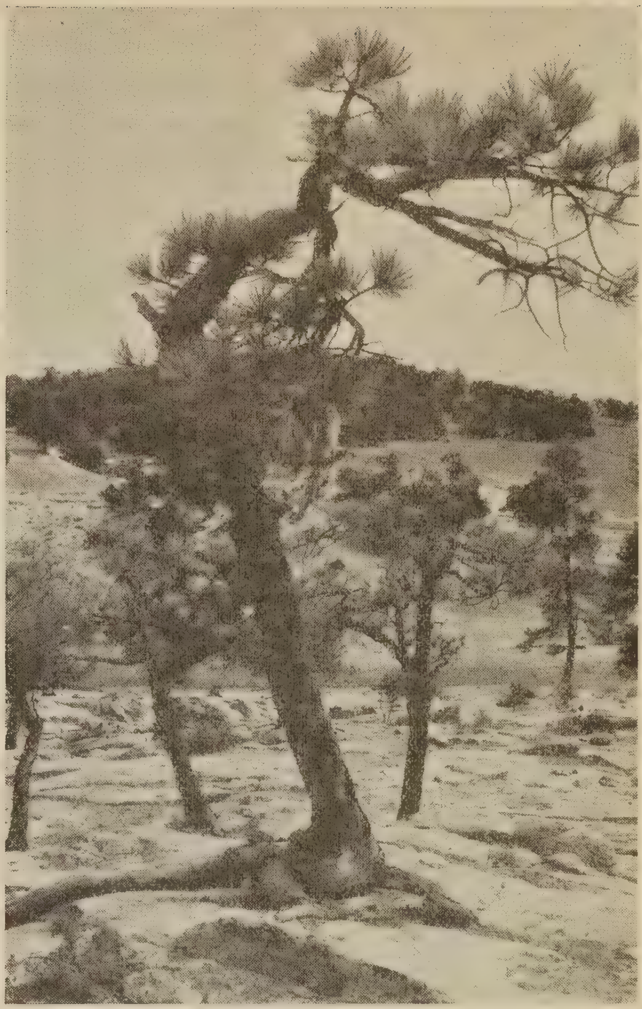
Help for the Indian

On an area of 17,000,000 acres in New Mexico and Arizona, including all of the Navajo, Hopi, and Zuni Reservations, extensive erosion-control activities have been started by the Soil Conservation Service.

The general objectives of the project are to conserve the remaining lands of the area by (1) checking destructive erosion and conserving the water supply, (2) regulating the use of forage and forest cover, (3) promoting the best practices of agriculture, forestry, and other phases of land use and, in cooperation with the Indian Service, integrating land use with the other arts, occupations, and problems of the Navajo people. The fourth broad objective is to furnish the Indians with profitable employment and useful training in land management insofar as is consistent with the national soil conservation program.

The problem is not a simple one of gully plugging. Its solution demands a combined effort of governmental agencies toward the economic and social rehabilitation of a great Indian nation, involving the right kind of education and the realinement of agricultural and grazing activity on an enduring basis. It has been necessary to convince the Navajo people that the situation is serious and that they must make a sacrifice to save their lands.

The first important step in the program has been the preparation of comprehensive range surveys upon which to determine suitable carrying capacities and



Exposed roots of yellow pine on rock slope. These roots could not have grown on bare rock—hence, the trees must antedate the denudation.

range-management plans. Parallel to the making of these surveys has gone a general reduction in number of livestock. With the completion of detailed range-management plans, the reservation will be divided into

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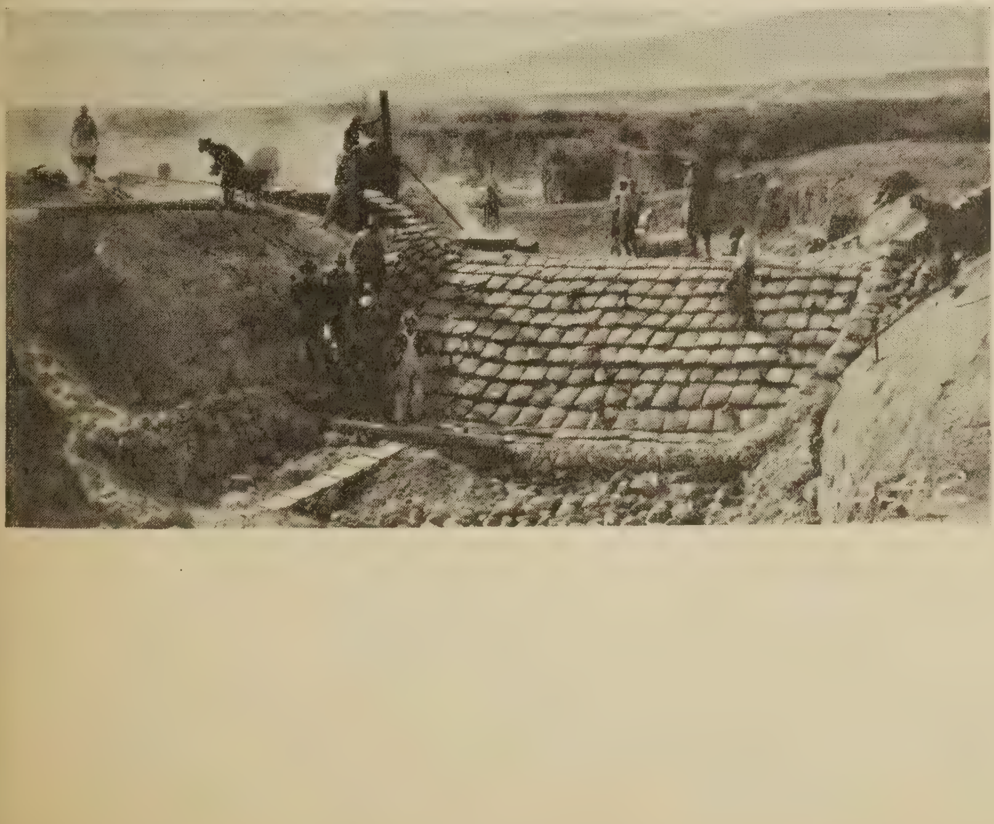

Laying asphalted bags on spillway. Note shingling; also, pipes for relieving water pressure. Freeman flats, Graham County, Ariz.

ACTIVITIES TO BE CORRELATED

Dillon S. Myer is announced as Chief of the important Division of Cooperative Relations and Planning. His triple responsibilities, as such, include cooperative relations in extension, cooperative relations in planning, and information.

In the report of the Secretary's committee on soil conservation, approved by the Secretary on June 6, recognition was given to the necessity of cooperation and correlation of State and Federal activities pertaining to the control of erosion and the safeguarding of the Nation's soils.

At the outset Mr. Myer will devote special attention to the development of proper working relationship between agricultural colleges, experiment stations, extension services, and the Soil Conservation Service in each State, and between the Service and the Agricultural Adjustment Administration, the Tennessee Valley Authority, the Resettlement Administration, the various bureaus of the Department of the Interior, and other Government agencies involved in the soil conservation program. The head of division will also have charge of informational activities and the working out of long-time plans for a progressive national program of soil conservation.

Mr. Myer comes to the Service ideally equipped for his large task. He received his B. S. degree in agriculture from the Ohio State University in 1914, and his M. A. degree in education from Columbia University in 1926. From 1914 to 1916 he was an assistant in farm crops at the Kentucky Agricultural Experiment Station and instructor in agronomy at the Kentucky Agricultural College. From 1916 to 1920 he was with Purdue University, engaged in extension work. From 1920 to 1922 he was county agent of Franklin County, Ohio. From 1922 to 1933 he was district supervisor of extension, Ohio State University.

Since 1933 Mr. Myer has been connected with the Agricultural Adjustment Administration, first as State agent in extension work, then as Chief of the Compliance Section, and more recently as Assistant Director of the Division of Program Planning.

Upon assuming his new post, Mr. Myer set forth on a 3-week tour of inspection and conference, to familiarize himself with conditions in the field. Part of this trip he made in company with the Chief of the Service, H. H. Bennett.

In introducing his appointee, Mr. Bennett bespeaks the hearty cooperation of every member of the staff.

SOIL CONSERVATION IN THE NAVAJO COUNTRY

(Continued from preceding page)

natural range units within which the Indians will be organized to carry the plans into effect.

Aside from restoring natural vegetation through range management, the Service aims to revegetate the ranges by such artificial means as will retain the greatest practicable amount of water where it falls. For this purpose, water is being diverted out of gullies, around gully heads, and spread over the flat and gently sloping ground to increase the natural growth of grass and other plants. Gullies that are too big for such treatment are being planted to quick-growing cottonwoods, willows, and tamarisks and, as rapidly as the stock can be produced, to food bearing trees such as wild plum, walnut, and honey locust. Denuded spots are being planted or sown to a great variety of native plants that are valuable for forage as well as for holding the soil.

Water diverted from gullies is being made available to the Indians, to the greatest extent possible, for the flood-irrigation of agricultural lands. It should be noted in this connection that less than 1 percent of the Navajo country is suitable for farming and that a substantial portion of this 1 percent would not be considered as farm land according to usual standards. In all, only 50,000 acres are devoted to farming, while the remainder is in range.

Much work remains to be done. The enthusiasm and cooperation of the Navajos, however, has been heartening, and since the work of restoration must be carried to a conclusion by the Navajos themselves, the partnership now being formed between the people and the agencies of Government is a most hopeful sign that the project will ultimately accomplish its objectives.

LABOR ADVANTAGES OF CONTOUR LISTING

By R. L. von Trebra

Regional Director, Albion, Nebr.

Many farmers signing cooperative agreements for an erosion control program were very skeptical as to the value of terraces and contour cultivation. Some of them jokingly referred to it as "tango listing."

Mike Wojcik was one of these skeptical farmers. His farm consisted of 306 acres of rough hilly land. The cooperative agreement called for the control of gullies, the retirement of some of the farm from cultivation, seeding to permanent pasture grasses and alfalfa and the construction of a system of terraces. On the terraced land contour cultivation and contour cropping was to be followed.

Horses Weak for Spring Work

Due to the severe drought of last summer, Mr. Wojcik, as well as many other farmers in the drought area, failed to raise enough feed for his livestock. His work horses had to subsist on the little roughness that was grown on the farm. At times they received a small portion of grain as a dessert. Mr. Wojcik's horses were in poor condition for spring work. Expressed in his own words, when he needed a two-horse team, it was necessary to hitch four horses together in order that the outside horses might hold up the middle team.

When corn planting time came around, Mr. Wojcik wondered what to do and how to contour list his terraced fields. R. R. Hinde, the agronomist who had worked out the erosion control plan for the farm, went into the field with Mr. Wojcik and helped him get started with the "tango listing." After the first day's listing Mr. Wojcik was "sold" on contour cultivation or working on the level.

Kept Operations on Level

He stated that his weakened horses could not have pulled a lister up the steep hills. By working his farm on the contour, his operations were kept on the level. He used four horses on a two-row lister and due to the fact that working was made easier, the horses were able to stand up under the strain of spring work.

Mr. Wojcik's experiences are similar to those of many others. Working rough land on the level has meant a saving of approximately 20 percent of the ordinary fuel consumption of tractors. They may be kept in high gear instead of second and low gear as was formerly necessary when pulling up and down hill.

His foot is on top of post set in 1926.

BERMUDA STRIP CATCHES SOIL

William Lloyd Neill, Arkansas farmer, finds Bermuda useful as a vegetative turfing grass for erosion control. He calls attention to a strip of pasture bordering his meadow that has controlled run-off from slopes in his unprotected fields. His fence was built separating a woodland from a strip of Bermuda grass on which later white clover and Dallis grass had been sown. More recently a new fence was built along the line of the old fence. The old fence posts now stand only 18 inches above the present soil level. That is, in 9 years soil carried from slopes of unprotected cultivated fields has been held and deposited along this fence row to a depth of 4½ feet. This same effect is observed under wind-erosion conditions.

Mr. Neill has 30 acres in pasture, 20 acres of which are new, but thriving and serving in the erosion control plan.

RESERVOIR SILTING RESULTS FROM PREVENTABLE EROSION, SURVEY SHOWS

Mud cracks on drying silt surface exposed by lake drawdown. Background shows the great width and depth of mud fill. Roosevelt Reservoir, Salt River, Ariz.

A progress report on reservoir surveys and investigations has been prepared by Henry M. Eakin, in charge of sedimentation studies.

It was because of the inherent relation of silting of reservoirs to problems of erosion control that the Soil Conservation Service inaugurated, in July 1934, an attempt at a general Nation-wide survey of the conditions of reservoirs with respect to reduction of storage by silting.

The ultimate objective is to establish information on the factors involved in the silting of reservoirs, the rates of silting, soil slope and climate conditions, and to correlate these with land use in watershed areas. Such a broad factual basis appears necessary to the sound determination of policy and practice of reservoir development and silt control.

Detailed Surveys Made

The work thus far done consists of detailed surveys of silt accumulations in representative reservoirs in the Southeastern, the South Central and the Southwestern areas, together with reconnaissance examinations of other reservoirs in the same territories incident to selection of more broadly significant cases for special study.

The direct purpose of each survey has been to determine the volume and distribution of sediment deposits accumulated in the reservoir during a known period of time, either the entire period of the reservoir's existence or a shorter period between an earlier survey and the current resurvey. From these data and the area of watershed, the average rate of silting per year per unit of drainage area is derived. This constitutes perhaps the most practical index to differences and changes in regional erosional conditions and expectancy of useful life of existing or contemplated reservoirs.

The following table is indicative of the magnitude of the silting problem as revealed in this preliminary report:

RESERVOIRS SURVEYED BY SOIL CONSERVATION SERVICE, 1934–35

Name	Location	Period	Years	Original capacity	Storage per square mile of drainage area	Annual silt accumulation per 100 square miles of drainage area	Annual depletion of storage	Total depletion of storage to date of survey
				Acre-feet	*Acre-feet*		*Percent*	*Percent*
Lake Michie	Durham, N. C	April 1926–January 1935	8.75	13,457	79.16	27.69	0.35	3.07
University Lake	Chapel Hill, N. C	June 1932–April 1935	2.92	2,076	76.92	87.90	1.13	3.29
Greensboro Reservoir	Greensboro, N. C	February 1923–August 1934	11.50	2,870	39.80	31.30	.78	9.05
High Point Reservoir	High Point, N. C	August 1927–August 1934	7.00	4,220	72.00	60.80	.84	5.87
Lake Concord	Concord, N. C	March 1925–May 1935	10.16	1,179	310.49	200.80	.65	6.57
Spartanburg Reservoir	Spartanburg, S. C	May 1926–July 1934	8.17	2,700	29.30	62.00	2.10	17.15
Lloyd Shoals Reservoir (Ocmulgee River)	Jackson, Ga	December 1910–March 1935	20.33	107,702	78.24	26.50	.56	14.58
Rogers Reservoir	Rogers, Tex	September 1922–September 1934	12.00	164	300.00	568.00	1.90	23.00
Lake Waco	Waco, Tex	April 1930–March 1935	5.00	42,223	25.41	61.78	2.43	12.16
White Rock Reservoir	Dallas, Tex	1910–1935	25.00	19,540	171.41	140.83	.82	20.54
Guthrie Reservoir	Guthrie, Okla	October 1920–May 1935	14.50	3,232	243.03	234.81	.97	4.01
Boomer Lake	Stillwater, Okla	March 1925–June 1935	10.25	2,794	306.11	182.01	.59	6.45
Elephant Butte Reservoir (Rio Grande River).	Hot Spring, N. Mex	January 1915–April 1935	20.25	2,638,860	100.29	76.97	.76	15.50
San Carlos Reservoir (Gila River)	Coolidge Dam, Ariz	October 1928–February 1935	6.33	1,247,999	92.15	43.05	.46	2.93

The data already in hand impel Mr. Eakin to conclude that the silting of reservoirs is a practical problem of the first order in all three regions, wherever accelerated erosion takes place.

Man Is Responsible

Observations made on the many other reservoirs visited but not yet surveyed, and on erosional conditions along all routes of travel emphasize the dependence of undue rates of silting upon man-induced erosion, he says.

In the Southeast, reservoir silting relates chiefly to erosion of deep residual soils as influenced by human occupation, the studies indicate. Lower rates were found to obtain in mountainous and other regions wherever the natural forest cover is practically intact. Higher rates are concomitant with poor agricultural practices in the lower Piedmont country. The report suggests the organized cooperation of the agricultural population toward better terrace and crop practices, structural and vegetational gully control, and the rededication of oversteep lands to noncultivated crops or forest growths.

Overgrazing Noted

In the Southern Great Plains higher rates of silting relate to erosion of sedimentary soils under defective agricultural and grazing practices. The surveys point to a need for greater attention to terracing and contour cultivation, to cover and strip cropping, and to the control of incipient gullies. In many places more restricted grazing and the restoration of the ranges are needed. Silt detention above reservoir level in broad tributary valleys in most reservoir watersheds could be effectively and profitably employed, it is stated.

In the Southwest, the survey makes plain, higher rates of silting are largely the result of overgrazing and its consequence of extraordinary sheet and gully erosion. Sheet erosion, perhaps, can be reduced in time through further restriction of grazing. Sediment from formation of arroyos and gullies can be reduced or largely prevented by engineering or vegetative methods. Silt detention above reservoir level in broad tributary valleys, by earth barriers, and by growth of vegetative screens, is highly practicable in many cases.

Selective Waste

It would also appear, in view of the indications of underflow and congregation against the dams in this region of muddy flood flow waters, that important reduction of rate of silting would be feasible by selective waste of heaviest-charged waters through low-placed outlet gates. Such waters remain fluid after considerable settling and concentration of mud charge, and are capable of selective movement toward a lower outlet. Under laws of stratification of liquids of different densities, sludges carrying 20 to perhaps 30 percent of solid matter should be subject to such selective movement for long distances above dams. This presupposes that selective evacuation be practiced from the start to maintain the bottom slope and

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The efficiency of this reservoir at Spartanburg, S. C., has been practically ruined due to the collection of silt and clay above the dam. Only the stream channel is open.

NURSERY PROGRAM UNIFIED IN INTEREST OF EFFICIENCY

To furnish camps and projects the planting materials necessary for a broad soil-conservation program is the function of 80-odd nurseries now set up or in process of being started.

Until now the development of nursery activities in the Soil Conservation Service has been largely spontaneous and more or less haphazard.

In August 1933 the Bureau of Plant Industry was given a grant for the establishment of erosion-control nurseries. These have operated partly as quantity-production units and partly on an experimental basis for assembling and propagating better materials than are now available in commercial, large-scale forestry operations.

A number of S. C. S.-E. C. W. camps initiated nurseries while they were under the supervision of Forest Service or other agencies. Mostly, they confined themselves to the growing of black locust.

Project Nurseries Started

Some of the original S. C. S. projects saw the need of starting nurseries to provide their own planting materials, financing them out of their own funds. As E. C. W. labor became available these nurseries have gradually been merged with the E. C. W. program.

In some instances cooperative agreements have been worked out with State forestry departments. The Service has at times provided equipment enabling State foresters to grow and turn over to it all needed materials without the necessity of any supervision on its part. At other times the Service has made definite growing contracts at fixed figures, with the State providing labor, seed, supervision, and land. In still other cases the Service has been able to purchase planting stock from State nurseries without preliminary arrangements.

Unique Arrangement

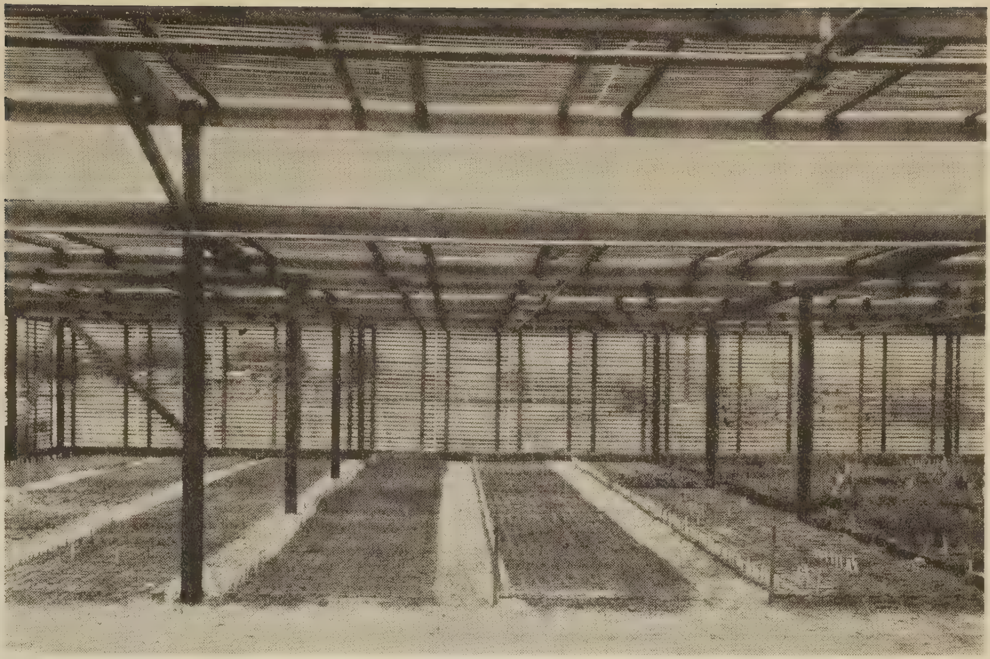
A unique arrangement has prevailed in Nebraska and South Dakota, where the United States Shelterbelt project has handled most of the details. There rental agreements have been entered into with commercial nurserymen for the use not only of land but also of facilities, tools, irrigation systems, packing sheds—in fact, everything except seed, supervision, and unskilled labor.

Finally, large numbers of trees have been purchased outright from private nurseries.

In view of the diversified needs of the 140 projects and 500 erosion camps, such a heterogeneous collection

Plots on which grasses are being transplanted, showing irrigation ditch in foreground.

Lath-house constructed at the Tucson, Ariz., nursery to propagate promising native and introduced erosion-control plants.



of nurseries may appear entirely in order. There are a number of very good reasons, however, to account for the centralization of nursery responsibility which has just been effected.

In the first place, projects have not been supplied with the planting materials they should have. It has been impossible to make arrangements for such materials until the project was well under way. In some States delays ensued and elsewhere the increased program has moved much faster than any possible nursery expansion.

It is important not only that suitable planting materials be available to the Service, but that they be grown where and how they ought to be, and that they be forthcoming when needed.

A further complicating factor has been the inability of any region to plan on a reserve supply to care for possible calamities. In this connection it should be recalled that the Zanesville, Ohio, project lost approximately 24 million trees in one flood. It can reasonably be expected that over a period of years disasters of this sort—floods, hailstorms, droughts, insect or disease epidemics—will be pretty sure to occur. It is only through a national, unified program that provision can be made for such emergencies. Through the planting of a small reserve in each nursery movement can be made toward a region which has lost its planting stock.

Only through a centralized program such as the Service is now initiating, can efficient nursery projects be maintained. A list of 80 nurseries may be too many, even for a service as extensive as ours. There is a certain minimum of size below which it is not at all feasible to operate a nursery. Trained personnel, suitable nursery equipment, long-time leases on land, and other factors make it highly undesirable to operate small units. On the other hand, there are limits as to how big a nursery should be in addition to the very practical one of growing materials as near to the place where they will be used as practicable.

Use of Black Locust

Due to the emergency nature of our program, it has been necessary in the past to use far more black locust than is ordinarily desirable. Most foresters and entomologists agree that the hundreds of millions of black locust that have been planted in almost pure stand are certain to bring on a serious infestation of the locust borer. The answer to this problem lies in mixed plantings in which black locust will constitute, at most, little more than 20 percent. The planning of such a variation in materials lies within the province of woodland management rather than of the nursery division. It is, however, only through centralization of nursery work that a better choice of materials can be obtained than that which has been used the past 2 years.

Throughout a large part of the country conifers are our preference. To indulge this choice, it is necessary

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ONE STREAM AND TWO FARMS

By A. F. Laidlaw

Gilmore Creek Watershed, Winona, Minn.

An excellent example of the value of forest cover on critical slopes exists on the farm of one whom we shall call Edward Jackson, in the Gilmore Valley area, near Winona, Minn., which is a part of the Root River project, no. 26. There are several slopes in this area as high as 70 percent with many between 40 and 60 percent. With such excessive slopes, the maintenance of an adequate forest cover becomes doubly important. Mr. Jackson has realized that not only the slopes, but the gullies and stream banks as well, must be kept covered with vegetation.

Near its mouth, the east fork of Gilmore Creek runs through the farm of Richard Moore, and then through that of Mr. Jackson. The line fence between the two farms crosses the creek about a quarter of a mile above the mouth of the fork. The downstream part of this creek lies entirely on Mr. Jackson's farm. Above the fence, the creek extends on up the valley across the adjacent farm. The fence represents a great deal more than a property boundary.

On the downstream side of the fence, the stream bank has not been grazed. It now bears a dense growth of cottonwoods and willows. This vegetation has very effectively held the width of the channel to a minimum, and the banks are low and sloping. On the other side, cattle have grazed to the very edge of the banks. Here the creek is much wider and the banks are not covered with soil-holding vegetation; instead, they are raw, open cuts which yearly dump great loads of silt into the freshets. This soil could be held in place by an ample protection of trees. The channel is from 2 to 3 feet deeper here and from 16 to 30 feet wider than where the banks are covered with trees.

The following table gives some indication of the value of the cover on the downstream farm:

Station	Width	Depth
Upstream:		
300 feet	43 feet	5 feet.
200 feet	40 feet	4 feet 6 inches.
100 feet	66 feet	10 foot cut.
At line fence	55 feet	6 foot cut.
Downstream:		
100 feet	26 feet	3 foot cut.
200 feet	19 feet	2 foot cut.
300 feet	18 feet	2 foot cut.

These figures show clearly what an ample vegetative cover will do toward holding an erosive stream bank in place.

Not Always Protected

At one time this downstream farm also had no cover along the banks, as one can clearly see where the old banks were located before the trees grew. This farmer however, realized the value of trees for stream-bank protection and has refused to permit grazing along the banks, thus giving the trees a chance. Along one small section of bank, the trees have been undercut and washed away. Here bank cutting is developing and will continue if not checked. Trees have not been planted to hold the soil in place.

About one-eighth mile above the mouth of this fork, the creek receives water drained from an area of approximately 25 acres. This water, concentrated in one large gully one-half mile long, has brought down a considerable number of rocks and silt. Cutting across a valuable hay meadow has been checked by permitting a large ungrazed area of woods to grow up on the fan at the mouth of the gully. This means that the lower part of the creek carries a larger volume than the upper and hence is more susceptible to cutting.

Thus, Mr. Jackson has demonstrated clearly the value of soil-holding vegetation on his farm. He has maintained his meadow in a workable condition at no outlay of expense to himself, whereas it would have taken much time and labor with lower resultant returns had the stream-bank cutting and gullying been allowed to continue.

SIX PRACTICAL POINTERS

Results of erosion control experiments on Cecil clay loam are summarized by the agricultural engineering department of the Alabama Experiment Station, as follows:

(1) Terraces, while often indicated on steep cultivated land to prevent gullying, alone do not sufficiently control erosion.

(2) Austrian peas or vetch will satisfactorily control erosion once they cover the ground.

(3) The losses from a single rain of material carrying plant food may be more than that supplied by a winter cover crop, if the land is left unprotected during the cultivation period.

(4) Planting in strips eliminates the necessity of having all the field plowed up or loose at the same time.

(5) "Filter" cropping (use of close growing crops) reduces sheet erosion between terraces very materially.

(6) Certain leguminous crops used as filter crops are satisfactory in preventing erosion.

SEVERAL REGIONS ESTABLISHED

In accordance with plans in formulation for some time, the following regions have been designated:

Region 1, northeast region.—New Jersey, West Virginia, Pennsylvania, Maryland, Rhode Island, Delaware, New York, Connecticut, Massachusetts, Vermont, New Hampshire, and Maine. Headquarters, Indiana, Pa.; regional conservator, A. L. Patrick.

Region 2, southeast region.—Florida, Virginia, North Carolina, South Carolina, Georgia, Alabama, and Mississippi. Headquarters tentatively located at Spartanburg, S. C.; regional conservator, Dr. T. S. Buie.

Region 4.—Arkansas, Louisiana, and Texas, except that portion of the western Texas Panhandle to be included in region 6. Headquarters to be announced later; regional conservator, L. P. Merrill.

Region 8, southwest region.—New Mexico, Arizona, Utah, and Colorado, and that portion of the Virgin River watershed lying in the State of Nevada. Headquarters, Albuquerque, N. Mex.; regional conservator, Hugh G. Calkins.

While it is planned ultimately to decentralize many functions from the Washington office to the regional office, it is anticipated that these changes will require some time to put into effect. Approval of such decentralization will be made as rapidly as adequate machinery can be set up in the regional office.

Natural cover of forest and grass will absorb rain water as it falls and protect the soil from erosion, but when the natural coverage is destroyed and no methods are used for controlling the rainfall, the rapid run-off water results in erosion.

PROGRESS IN EMPLOYMENT OF RELIEF LABOR

The most recent weekly report showed an increase of 2,172 employees transferred from the relief rolls to the Soil Conservation Service. On one watershed the relief-labor quota had been exceeded by more than 56 percent. On another the local Service requirements had absorbed all available labor of a relief classification. Throughout the country, projects are making an intensive effort to cooperate in the works program by meeting their assigned quotas.

Following is a statistical summary, as of September 21:

State or watershed	Number of relief workers	Relief quota	Regional director	Percentage of relief labor quota
South Carolina	1,210	775	Buie	156.1
Colorado	617	772	McClymonds	79.9
New York	329	420	Howe	78.3
New Jersey	202	268	Lee	75.4
Pennsylvania, Maine	447	605	Patrick	73.9
Virginia	211	347	Keil	60.8
Wisconsin, Minnesota	256	431	Davis	59.6
Nebraska	124	214	vonTrebra	57.9
Georgia	409	795	Rast	51.4
East Texas	221	450	Merrill	49.1
California, Nevada	446	931	Reddick	48.0
Illinois	158	337	Fisher	46.9
Central Texas	300	647	Geib	46.4
Navajo	565	1,306	Matthews	43.3
North Carolina	540	1,354	Stallings	39.9
Alabama, Florida	233	606	Bailey	38.4
Mississippi	272	758	Anders	35.9
Kansas	156	445	Duley	35.1
South Dakota, North Dakota, Montana.	270	790	Clemmer	34.2
Iowa, Missouri	T378	1,123	Uhland	33.7
Ohio, West Virginia, Indiana, Michigan.	T337	1,052	Cutler	32.0
Gila	358	1,400	Fleming	25.6
Louisiana	156	688	Mims	22.7
Oregon, Idaho, Washington	94	425	Rockie	22.1
North Texas	69	576	Finnell	12.0
Kentucky	35	314	Alberts	11.1
Arkansas	91	888	Sargent	10.2
Rio Grande	65	1,040	Smith	6.3
Oklahoma	52	1,051	Winters	4.9
Wyoming	3	370	McClymonds	.9
Maryland	0	185	Bruce	0
Utah		162		
Total	8,604	21,552	Average	39.9
BY REGIONS				
1. Northeast region, no. 1 (Pennsylvania, Maryland, Rhode Island, New Jersey, Delaware, New York, Connecticut, Massachusetts, Vermont, New Hampshire, Maine.)	978	1,478	Patrick	66.2
2. Southeast region, no. 2 (Virginia, North Carolina, South Carolina, Georgia, Alabama, Florida, Mississippi.)	2,875	4,635	Buie	62.0
3. Southwest region, no. 8 (Colorado, Wyoming, Utah, Arizona, New Mexico (latter 2 include Navajo, Gila, and Rio Grande Watersheds).)	1,608	5,029	Calkins	32.0

A GILA RIVER GONE BERSERK

By E. Edgar Fuller

President Gila Junior College, Thatcher, Ariz.

Bank cutting on the Gila River in July 1934. This picture and its companion were taken a few minutes apart.

On April 8, 1879, Hyrum Weech arrived in the Gila Valley to make his home. It is difficult for one who lives in that valley at the present time to believe that the view which greeted him was so totally unlike that which one sees there today. Yet scores of old residents tell the same story about the condition of those days, so graphically related in the autobiography of this remarkable pioneer:

> The river, winding its course through the valley, was fringed on both sides with cottonwood and willow trees. The valley was covered with groves of mesquite trees and stretches of open ground covered with grass. The Gila then was a stream with well-defined banks and sloping, graveled bottom. It was about 4 to 6 rods wide.

Today, instead of a quiet, clear stream less than a hundred feet across there is a winding channel on the average of more than 2,000 feet wide. Scores of farms have been washed away and the river channel occupies more than 16,000 acres of once rich farm land. The water rushes down in muddy torrents after each rain, carrying vast quantities of silt into the great San Carlos Reservoir.

The once-thick growth of mesquite and other trees has been so completely cleared away that firewood now has to be hauled from the mountains. With the clearing of the land the river has cut farther and farther back into the farm lands. Today it occupies about one-third of all the arable land of the valley. Some of this can be reclaimed, and many of the dangers of future damage can be avoided by a program of soil conservation, but much has been lost forever.

What is true of the river is equally true of the small tributaries. Many of these runs and gullies have become veritable canyons due to overgrazing and removal of vegetation along their banks. One of the most spectacular and tragic examples is the San Simon wash, a chasm more than 60 miles long which is in many places hundreds of feet wide and between 20 and 30 feet deep.

The true story of the San Simon is almost unbelievable. Fifty years ago there was a great unbroken meadow from Rodeo to Solomonsville. Drainage was well spread over the area and each heavy rain replenished the artesian wells and water holes without a

rapid run-off. Nevertheless, the most severe storms deposited some debris upon the lands of a few farmers living near Solomonsville and they excavated a channel about 20 feet wide and 4 feet deep for a short distance to aid the drainage into the Gila. A few funneling levees and furrows to help the drainage into the main channel completed this part of the work. Consistent over-grazing and occasional droughts and heavy rains did the rest.

A Destruction That Never Pauses

An empire of 1,250,000 acres, stretching from the 21,000 acres of timber on the upper end of the watershed through a succession of grassy plains to the fine agricultural land of the lower areas, has already been partially destroyed. Thousands of acre-feet of silt have been washed into the Gila and thence to the reservoir below. The wash grows larger year by year.

Such instances as these might easily be multiplied because practically every wash tributary to the Gila tells the same history. The young children of Hyrum Weech, in the early days of the settlement of Pima, ate their picnic lunches on the banks of Cottonwood wash. It was a tree-bordered creek only a few feet wide. It is now a deep dry wash similar to the San Simon, more difficult to control each year.

The actual destruction of the land is only one phase of the problem of the watershed. Perhaps the 40,000 acres of rich irrigated farms around Duncan and Safford could be bought and paid for by the money it would take to prevent their destruction. Over a long period of years the entire San Simon Valley might profitably be abandoned, surrendered as worthless to the forces set in motion by the carelessness of man. But this is not the whole story. Apart from the importance of preserving the productive capacity of the soil for future generations, more immediate reasons make it imperative that everything possible be done to control erosion and floods on the Gila.

Menace to Coolidge Dam

Continued erosion along the upper Gila River will doom the Coolidge Dam and the lands below it. Already the cost of removing silt from the distributaries of the San Carlos project is more than $100,000 each year. Without erosion control the life of this project will undoubtedly be made shorter by many years. The welfare of the upper valley is in this matter the welfare of all who use the waters of the Gila.

The soil-conservation program goes to the heart of the problem. Instead of ruined and abandoned lands, there is a vision of the future that includes the best that Hyrum Weech saw when he gazed on a virgin valley in 1879. Rebuilding of soil, the planting of trees and grass, and an adequate and steady supply of water are among the objectives.

Characteristic erosion of black lands, Rogers, Tex. Gullies are developing where plough rows run with the slope.

RESERVOIR SILTING

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a deep sludge pocket approaching the dam. Silt deposits against the dam and in adjacent deeps reduce the force of selective flow and the thickness of muddy water accumulation at the dam. They thus preclude the possibility of deferred development of optimum mud-evacuation practice.

Clear Waters Move On

Without such practice it is a frequent occurrence for clear waters, which have deposited their load in the reservoir to be wasted over the spillway, to make room at the bottom for a new body of very muddy water. This would appear to be the worst possible arrangement for shortening reservoir life. On the other hand, since the predominant volume of solid matter that encroaches upon capacity of these Southwestern reservoirs is composed of finer grained silts and clays, long held in suspension before final settlement and semisolidification, it appears that a very notable lengthening of useful life of present and future reservoirs in this region should follow appropriate development and adoption of a scientific practice of selective mud evacuation.

NURSERY PROGRAM

(Continued from page 9)

to make plans for several years ahead, inasmuch as this kind of stock must be at least 2 years old, and preferably 3.

Miscellaneous shrubs for game cover, and other special plants, in addition to assisting erosion control, are able to furnish something of use to the farmer. It is necessary that the nurserymen who are collecting, growing, and testing such materials have quite a different type of training from that demanded in the large-scale production of black locust.

It is true that the Service, in planting some 400,000,000 or 500,000,000 trees per year must stick very close to proved species. On the other hand the execution of a broad program demands for the future something decidedly better than is now available in forestry planting. It is only necessary to cite known examples such as hybrid-walnut trees, which produce 20 times the amount of growth that ordinary walnut trees produce, honey locust yielding 2-foot pods of high sugar content, black locust resistant to the borer, native plums much better than miscellaneous seedlings, to indicate that we should by no means be content with materials now available for large-scale production.

Testing on Large Scale

Likewise, although the use of plant materials close to the place of origin is a good general practice, it by no means follows that we must or should confine our efforts to such materials. It is only necessary to point

to present-day agronomy and horticulture to see that almost without exception commercial crops reach their highest stage of perfection several hundred or even several thousand miles from the place of origin. This does not imply that without trial we should move materials long distances and plant on ordinary cooperating farms large numbers of materials which have not been tried in the vicinity. It does suggest, however, a large amount of moving about and testing of small lots.

Specifically, it is planned that a few nurseries shall be especially occupied with assembling, propagating and testing relatively large numbers of species of plants. This list includes Fairhope, Ala.; Chapel Hill, N. C.; Zanesville, Ohio; Elsberry, Mo.; Ames, Iowa; Tucson, Ariz.; Pullman, Wash.; Mandan, N. Dak.; Lincoln, Nebr.; Stillwater, Okla.; Albuquerque, N. Mex., and Winona, Minn.

IS CLEAR WATER MORE EROSIVE?

SISTEMAZIONE DEI TORRENTI E DEI BACINI MONTANI, by Carlo Valentini. Ulrico Hoepli, editor, Milano, Italy, 1930. 20 lire. Translated from the Italian by Albert Chiera.

Mr. Valentini, who is the author of several technical volumes, has written a very interesting book on "The control of torrents and mountain basins", which I have translated from the Italian. Without any attempts to support the author's reasoning, I shall give the substance of what he says.

Among the many principles dealt with, he discusses the influence of materials on the movement of water and proves by equations and diagrams that (1) water, charged with materials, moves more slowly than water free from them and, (2) that clear water possesses a greater erosive power.

These two principles as set forth by the author have a bearing on the difficulties encountered in controlling mountain torrents. Since, in the usual procedure, to manage an unruly stream the engineer starts from the premise that, by regulating a water course, the velocity is reduced so that deposits take place, he may underestimate the fact that the water released from its burden becomes clearer and, therefore, more erosive, and that its velocity increases in proportion.

The author's arguments are as follows:

Let us assume that a stream loaded with material runs in a channel at a given velocity, and due to this velocity the material is held in suspension. Let us assume, also, that for some reason or other the stream reaches a broad stretch over which it is forced to spread. Naturally, its velocity decreases, and the material held in suspension is immediately deposited. The stream at this point, having unloaded itself of the burden, becomes clear and assumes, consequently, a greater velocity. Becoming, therefore, more erosive, it begins instantly to scour down the bed and to lift material of the size corresponding to its newly acquired velocity, and after having reached a certain point of saturation proceeds to carry the material and to unload it again when its velocity may, for any reason, diminish.

The foregoing explanation is corroborated also by the examination of a diagram of a longitudinal profile of a stream which shows the theoretical ideal compensation slope and a profile prior to its regulation, wherein it is seen almost invariably that wherever a deposit of material occurs, an erosion immediately follows.—Albert Chiera.

EDITOR'S NOTE.—The energetics of debris-laden waters are currently being made the subject of experimental investigations by the Soil Conservation Service in cooperation with the California Institute of Technology, at Pasadena.

EROSION MAPS READY

A map showing erosion conditions throughout the United States (scale: 1 to 5 million) is now available for distribution.

State maps (scale: 1 to 500 thousand), showing conditions in more detail, are being prepared as rapidly as possible.

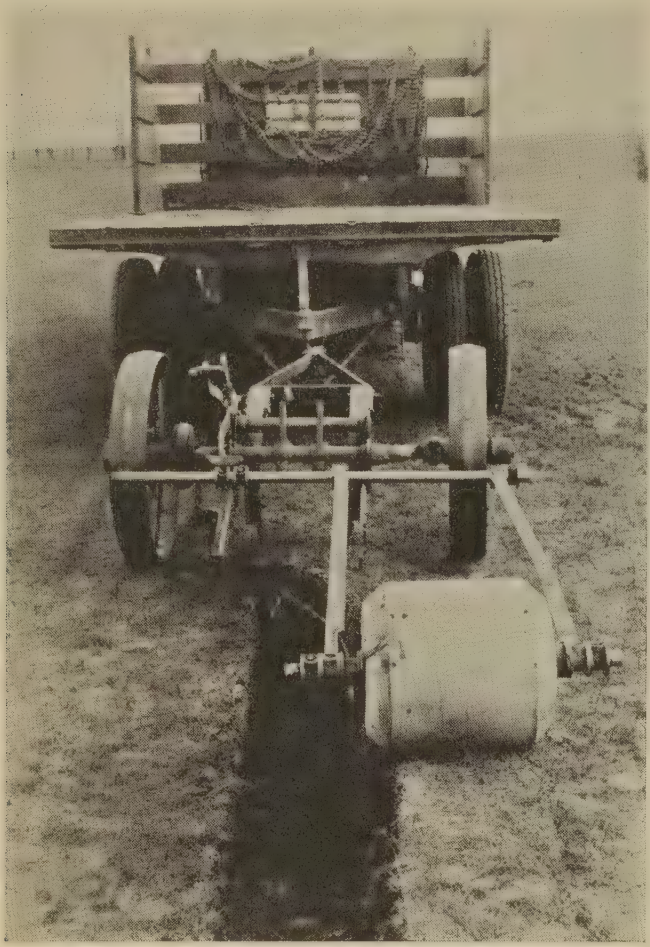
The following will be ready before October 1: Maine, Vermont, New Hampshire, Massachusetts, Connecticut, New York, Ohio, Pennsylvania, Maryland, Delaware, West Virginia, Kentucky, Virginia, Tennessee, North Carolina, South Carolina, Florida, Louisiana, North Dakota, Minnesota, Michigan, Iowa, Illinois, Kansas, Oklahoma, Arkansas, Mississippi, Alabama.

Obtainable after October 15: Missouri, Georgia, Indiana, South Dakota, Nebraska, Wisconsin, Texas.

Ready December 1: Washington, Oregon, and California.

For one reason or another maps for the following States will not soon be available: Montana, Idaho, Wyoming, Nevada, Utah, Colorado, Arizona, and New Mexico.

CONTOUR FURROWS, GRASS UP, FIRM AND UNIFORM



Typical of the specialized machinery which is being developed to assist the work of conserving the Nation's soils is the ingenious device at the left, in use on the Mankato, Kans., project. A U-knife slices a furrow some 4 inches deep; curved rods guide the severed strip upward and to the side where the sod is neatly deposited grass side up. A roller then packs it firmly in place.

Since this picture was made, the roller has been improved by having its surface made somewhat concave so that the pressure will be greater at the edges. Various other improvements are in an experimental stage.

The results of using this machine are shown in the lower view, the serpentine contour furrows serving notice that here is a pasture where run-off will in the future be restrained.

Contour furrows conserve moisture, help to develop more permanent pastures, keep seed from washing away, promote a greater variety of vegetation.

REPORT ON PROJECT PROGRAMS TO AUGUST 31, 1935

A. General	Total
Number of private-land projects	37
Number of Federal-land projects	3
Acres in private-land projects	3, 928, 500
Acres in Federal-land projects	43, 488, 000
Number of farms in area	30, 276
Number of trainees at end of month	156
Number of C. C. C. camps operating within project areas	135
1. Farms put under agreement	11, 982
2. Acres in farms put under agreement	1, 597, 263
3. Agreements canceled	202
4. Acres in farms on which agreements canceled	27, 137
5. Percentage of farms under agreement	39.6
6. Percentage of total area under agreement	40.7
7. Number of acres completed by detailed erosion surveys	2, 812, 915
8. Number of acres yet to be surveyed on all farms included in cooperative agreement where no erosion survey has yet been made	248, 988
9. Number of acres yet to be surveyed on farms included in cooperative agreements where *only* the tilled land has been surveyed and where forest or other nontilled areas have not yet been mapped	144, 454
10. Number of acres needing treatment	1, 286, 080
11. Acres for which no special erosion-control practices are planned	299, 915
12. Number of acres under treatment and finished	1, 106, 663
13. Number of farms with treatment finished	3, 074
14. Number of acres on which treatment finished	679, 969
15. Number of invitations received from farmers to make agreements	13, 495
16. Number of acres in farms for which invitations received	1, 830, 883

B. Data on farms under agreement	Total
17. Acres strip cropped before contract	6, 121
18. Acres agreed to be newly strip cropped under contract	305, 199
19. Acres actually newly strip cropped	187, 896
20. Acres contour tilled before contract	215, 716
21. Acres agreed to be newly contour tilled under contract	404, 902
22. Acres actually newly contour tilled	243, 253
23. Acres terraced before contract	132, 866
24. Acres agreed to be newly terraced or reterraced under contract	374, 335
25. Acres on which proper rotation practiced before contract	131, 482
26. Acres on which proper rotation newly agreed under contract	596, 239
27. Acres on which proper rotation actually newly followed	450, 597
28. Acres contour furrowed before contract	2, 355
29. Acres agreed to be newly contour furrowed	55, 238
30. Acres actually newly contour furrowed	22, 882
31. Acres in cultivation before contract	858, 785
32. Acres agreed to be taken out of cultivation	134, 818
33. Acres actually taken out of cultivation	102, 447
34. Acres agreed to be retired to permanent hay and pasture	109, 103
35. Acres agreed to be retired to forest	40, 366
36. Increased acreage erosion-resisting crops agreed	185, 569
37. Decreased acreage clean-tilled crops agreed	105, 692

C. Engineering	Total
38. Miles of terraces constructed	11, 230
39. Acres protected by terraces	150, 471
40. Number of permanent terrace outlet structures completed	28, 021
41. Number of temporary terrace outlet structures completed	45, 563
42. Square yards of terrace outlets seeded and sodded	3, 384, 780
43. Linear feet of terrace outlet channels completed	2, 726, 379
44. Number of temporary dams, gully control, constructed	258, 822
45. Number of permanent dams, gully control, constructed	88, 119
46. Square yards, bank sloping, gully control, constructed	6, 413, 798
47. Linear feet diversion ditches, gully control, completed	1, 279, 452
48. Acres drainage area of gullies controlled	346, 012
49. Cubic yards of fills in earth dams	1, 780, 242
50. Linear feet of water spreading dykes	301, 945

D. Forestry	Total
51. Acres planting forestation	21, 931
52. Acres planting gully planting	16, 770
53. Square yards planting bank protection	21, 763, 028
54. Man-days nursery work and plant collection	47, 316
55. Seed collections, hardwoods, pounds	257, 631
56. Seed collections, conifers (cones), bushels	4, 379
57. Forest management, forest under management, acres	180, 165
58. Forest management, woods pasture fenced, acres	47, 566
59. Forest management, timber estimating, forest types, etc	550, 638
60. Forest management, improvement cutting, acres	2, 631
61. Forest management, number demonstration plots	259
62. Number of cooperators, wild-life management	2, 141
63. Rods fences constructed	393, 567
64. Acres fire hazard reduction	21, 716
65. Man-days fire control	4, 785

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SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE · WASHINGTON

NOVEMBER
1935

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Soil Conservation is issued monthly by Soil Conservation Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Soil Conservation seeks to supply to workers and cooperators of the Department of Agriculture engaged in soil conservation activities, information of especial help to them in the performance of their duties, and is issued to them free by law. Others may obtain copies from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents, a copy, or by subscription at the rate of $1.00 per year, domestic. Postage stamps will not be accepted in payment.

WELLINGTON BRINK — EDITOR

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

H. H. BENNETT
Chief, Soil Conservation Service

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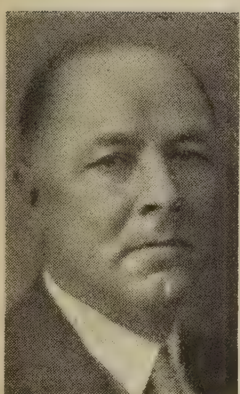
ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON

A LOOK AT SOME OF THE WESTERN PROJECTS

By H. H. Bennett

Chief, Soil Conservation Service



Mr. Bennett.

The progress being made on the western soil-erosion demonstrations, which I have just visited, is most encouraging. Considering the brief period the work has been under way, the accomplishments thus far portend a veritable agricultural revolution—the throwing off of shackles of soil misuse and abuse that had their origin in a national misconception with respect to our supposedly inexhaustible supply of crop and grazing lands.

I saw unmistakable evidence that the hundreds of land users cooperating with the Service have come to understand the significance of cultivating and overgrazing all kinds of land, as if it all, steep and level, clay and sandy, were equally adapted to continuing productive use. The effective practices employed in the demonstration areas are beginning to trickle across the project boundaries. Farmers outside are beginning to work these new and fundamental soil-protection methods into their system of land use.

In the more humid parts of the great wheat belt of Washington, Idaho, and Oregon—the Palouse region, where rain and melting snow have been stripping off the better topsoil from the most productive wheat lands on earth—I saw numerous highly erodible fields planted to combinations of sweetclover, alfalfa, and grass, that is, to crops which not only stop erosion but cause the absorption of practically all of the rain and melting snow. Such use of the land, as a predominantly accepted farm practice, was the more astonishing to me because only 6 years ago I had with small success searched this same region for fields planted to just such.

In other words, virtually nothing was being done 6 years ago to control erosion in the Palouse country, although much was being done to encourage it. Now the countryside is erosion conscious, farmers are going into battle against the evil, and splendid headway is being made.

On the watershed of Palouse River, above Pullman, Wash., more than 10,000 acres, formerly used for wheat and peas under a system of summer fallowing (with approximately half of the cultivated area under clean summer fallow every year), have been planted to various combinations of sweetclover and grass and of alfalfa and grass. Probably this practice in itself saved annually more than a billion and a half gallons of water that formerly ran off as so much waste, and it has given full protection to lower lying areas over which detrimental erosional debris was being washed from exposed subsoil above. Many rapidly expanding gullies have been controlled, covered over, and seeded to stabilizing vegetation. This has obviated the necessity of making hazardous crossings and troublesome detours in operating heavy farm machinery.

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Gullying in bean field in Las Posas, Calif., project. The whiteness of the gully sides is due to exposure of the subsoil as a result of repeatedly cultivating after each rain.

Many of the larger ravines which had drained away subsoil moisture to such an extent that the productivity of the rich alluvial topsoil had greatly deteriorated, have been closed up with dams built by E. C. W. labor. Behind these dams, pools of water have collected. Normal water table conditions have been reestablished, and wild ducks have come to breed along ravines that only a little while ago were dry as desert arroyos, all summer long.

Retired and Stabilized

Numerous areas of severely washed land and land susceptible to destructive washing have been retired from cultivation and planted to trees or permanent grass. Much of this land was so steep that harvesting machinery had to be fitted with leveling devices to prevent overturning. In some places bedrock is now protruding where before there was a good depth of highly productive soil. I saw numerous flocks of sheep grazing on these "retired" lands, now stabilized with clover, alfalfa, and grass. The sheep were en route from high summer ranges to winter pastures, and the landowners were receiving grazing rentals that were highly pleasing to them.

Over in Oregon, Ed Hill has put a far-reaching erosion-control program into operation. In this region of superlative wheat soils, wheat farmers who seemingly thought little of soil conservation now see what erosion is doing, and has done, on numerous slopes where the land's very steepness should have aroused at least a suspicion about the catastrophe that was taking place in their fields. Now field after field is being planted to grass and sweetclover or alfalfa, particularly where the soil has washed so thin that bedrock protrudes almost as much as in the "scabland" sections of the Big Bend of the Columbia River.

"Chiseling" the Stubble

Hill has a large number of farmers plowing their wheat stubble halfway under instead of burning it off as they formerly did. Moreover, many of them are chiseling wheat stubble so as to leave much of the stubble above ground, and leave the soil in a decidedly cloddy condition. There can't be much washing under such soil treatment, but no one knows just what will happen to the yield of the next grain crop. It may be depressed a little. Here we need experimental work to determine how deep to chisel, how much straw to leave above ground, when to disk, etc.

The erosion-control work in the bean and fruit districts of the Corralitos, Arroyo Grande, and Las Posas districts of southern California has definitely assured continuing stability to numerous ranches where conditions threaten to force abandonment of land worth from $300 to $1,000 an acre. In this general region, highly productive valley land is being

dissected with deep barrancas (California gullies) caused by excessive run-off of rain-water from adjacent unprotected steep slopes. The slopes themselves, which have been producing profitable bean crops, are splotched with brown clay areas from which the last inch of topsoil has been washed off—a process that changes good land to almost worthless land. A considerable acreage which has paid splendid dividends to its operators has already been farmed to the death state, while lowlands valued at $1,000 an acre are threatened by the deposition of relatively infertile material brought down with the increased run-off from erosion-exposed clay subsoil on the hillsides.

A small gully in the Las Posas project being stabilized by dams made of mesh wire and tarred burlap. One rain has resulted in complete silting. This gully is now ready for the planting program.

Cheap at the Price

I was somewhat disturbed about the costly appearance of a control job on a waterway in the Corralitos project. This waterway was doing great damage to the land—fine Yolo loam along the lower reaches and good sandy Moro Cojo soil upstream. It was almost 3 miles long, and the cost of its control, plus the supplemental work in adjacent fields, amounted to about $10,000. Here is approximately what we found from the lower end to the upper end near the crest of the watershed—the major installations and vegetative treatments:

A. Thirty-eight 5-foot control drops made of cement and rock rubble along a considerable length of the barranca;

B. Two thousand feet of vegetated, sloped sides, with numerous redwood drops;

C. About 1 mile of control with (*a*) waste oil field iron pipe and wire dams and (*b*) vegetated slopes;

D. About 1,400 feet of cement-lined gully;

E. About 900 feet of gully control with scrap-iron pipes and wire stabilization dams; and

F. About 2,500 feet of vegetated gully sides, with cement drops.

Ten thousand dollars on this job, of which the gully work roughly detailed above was the backbone, frightened me a little until I learned that by no other conceivable method was it possible to save the lands on this little watershed, in which a number of families live happily, and in which the land has a value of not less than $200,000. Erosion here was so rapid that we were able to photograph apple trees with deposits of erosional debris more than a foot above the crotch. Without this work I think 15 years would have seen most of the 500 acres permanently ruined, and an additional acreage downstream severely damaged by overwash.

Arroyo Grande was an "eye opener." I can think of no other place in the United States where erosion is any worse. Cultivation really got under way here about 10 years ago, but already many slopes have been destroyed and good bottom land buried with as much as 10 to 14 feet of sand. I saw a wire fence whose upper strand was partly covered by sand which had washed down from land worth from $150 to $200 an acre to cover land worth $400 to $500 an acre. This fence, with its upper strand covered, had been erected on top of another wire fence that had been covered previously in the same manner.

The staff and the cooperators at Arroyo Grande have already stabilized a considerable part of the project area and they will save much more of it, given a little time. On the job here, at the helm of one of the E. C. W. camps, is Roy Carberry—the man who is said to have steered the herculean undertaking to control the famous Colorado River break years ago—a job that saved Imperial Valley from inundation.

The farmers within these three projects are cooperating splendidly in the readjustments of land use called for under the erosion program. While I was in the State, one operator managing a tract of 822 acres of upland and valley land, most of it tilled, agreed to the retirement of 700 acres from cultivation so that erodible slopes might be stabilized with grass and trees.

Fruit Trees on Contour

It is my opinion that probably the most efficient handling of cultivated, erodible slope land to be seen anywhere in the United States is to be found in the Las Posas-Santa Paula district. Here, on declivities frequently exceeding 30 percent, with a highly erodible soil, fruit trees are planted on the contour and cultivated in such manner as to develop a steplike topography. Eventually the trees grow about midway from bottom to top of the sloping face between the benches. These sloping faces are maintained in a protective cover of grass, alfalfa, Australian saltbush or other stabilizing vegetation, with cultivation and irrigation furrows restricted to the flat or upper part of the bench. Land thus treated lost no soil and very little water during a single cloudburst in 1934, when similar untreated plowed slopes lost in the neighborhood of 500 tons of soil per acre. Such an accomplishment is almost unbelievable until you study the details of this well-nigh perfect method of land stabilization.

Preserving Indian Lands

The work on the Navajo Indian Reservation has already gone far enough to indicate success with the program devised to preserve the lands and life of this tribe of Indians. At the Mexican Springs project, one tract of 50,000 acres brought under protection from overgrazing has made such recovery that much land which 3 years ago was largely bare of valuable forage plants is now so stocked with blue grama and western wheat grass that one Indian has actually cut a stack of hay from it. By a simple process of diking, storm water rushing out of the hills has been distributed in such manner that the silt has been caught and the

An excellent example of how gullying destroys valuable valley land in southern California.

Strip crops on bean fields, Ventura County, Calif. The walnut trees in the foreground are on high-priced valley floor land subject to damage by excessive run-off and wash-off from the steep slopes.

water absorbed by the flat, drought-plagued valley lands; and on these areas such recovery of grass has taken place that good hay could be mown from hundreds of acres. On some of this land a yield of corn in excess of 40 bushels an acre was predicted for this year's crop.

As rapidly as possible the entire Navajo Reservation of approximately 16,000,000 acres is being surveyed to determine the location and extent of areas available for spreading of run-off water and resultant protection against erosion. This method of water control absolutely stops arroyo cutting in the valleys and adds new soil to areas impoverished or depleted by wind and water erosion.

Nailing Down the Dunes

In the "dust bowl" of the Texas panhandle much land that seemed doomed to desert conditions last spring, when dust storms were ripping the plains to pieces, has been stabilized by listing, contouring, and seeding to adaptable soil-holding vegetation. Some of the recently-created desert areas are still drifting in dune formations, and are continuing to damage good land on the lee side. It is believed, however, that most of these wind-plagued areas can be controlled by nailing down the windward sides of the dunes with appropriate plantings of such crops as sorghum, Sudan grass, and small grain.

At one place on a 600-acre tract of 1935 desert, I was able on October 12 to collect approximately a quarter pound of drifting sand within 2 minutes by holding the end aperture of an ordinary envelop about 1 inch from the surface of the ground during a light breeze. Apply this rate of movement of the earth's crust to a considerable area, and you will gain some conception of what a splotch of newly created desert really means in the way of complete land instability and worthlessness.

Checking Wind Damage

I was greatly pleased with what I saw on the wind-erosion demonstration project near Huron, S. Dak. Real progress has been made in a short time. Farmers who were skeptical in the beginning have become enthusiastic supporters of the program. There is no question in my mind but that a really tremendous thing has been started here—the beginning of a new conception and a new practice of land use. This use aims fundamentally at the stabilization of land against impoverishment by wind but effective results call also for better utilization of rainfall. The basis of procedure is to provide adequate protection by using the various kinds of soil according to their specific needs and adaptabilities. Some highly erodible areas will have to go back to grass, or to the condition that nature employed to protect the entire Great Plains region for undeterminable thousands of years.

With respect to land that is to be continued in cultivation, it will be necessary to yield in some measure to the lessons so patiently taught by the wisest teacher of us all—"Mother nature." If all the land is stripped of vegetation and the soil kept finely pulverized with plows, there will be more and more blowing.

If we are to preserve these rich soils, part of the land must be kept under a protective cover of soil building, sheltering crops. This can be done in a strictly practical way by seeding strips of corn, grain, sorghum, sweet clover and small grains across the fields at right angles to the prevailing winds. Such a system can be made to give—has already given—nearly complete protection; and handled upon a rotation basis, it can be made to replenish the soil with the spongy, life-giving humus that was dissipated under the old system. This and other things are being worked into the regional farming systems in a thoroughly cooperative manner by the service staff and the farm operators.

Abandonment Forestalled

What has been done on the August Jungemann farm, near Wolsey, S. Dak., can be done on thousands of other farms in the Great Plains. Last spring the owner of this farm is reported to have decided on abandonment of the place, so disastrous had been the effects of soil blowing. The entire tract of 160 acres had been affected. Scarcely a sprig of vegetation remained. Loose, shifting sand was piled along the fences and about the buildings; yet this farm had supported the Jungemann family for more than a quarter of a century; two members of the family had gone to college on the products of the soil.

The owner did not, however, leave his farm. Now he is not likely to leave, for the farm has been saved and is rapidly being stabilized. The saving involved many things, with still others yet to be done.

Hampering hummocks of wind-drifted sand have been leveled down on about 140 acres; nearly 120 acres had to be listed as quickly as possible. Strip farming had been inaugurated on approximately 120 acres, with corn, small grain and sweetclover planted in rotation, with grass and alfalfa seeded in the irregular field corners. A 10-acre woodlot had to be cleaned up and sand drifts leveled along 2,500 feet of fence lines. About 20 acres will be retired to grass and something like 18 acres planted to trees to serve as windbreaks along the south, west, and north sides of the farmstead. Formerly there were only 2 fields on the place, 1 for small grain and 1 for row crops.

This splendid practical job of soil protection, and many others like it, is highly gratifying. With the kind of cooperation prevailing between farmers, the Service, and the State colleges of agriculture, success in the stupendous task ahead is certain. That task, however, is scarcely begun; it must be persistently pressed, improved, enlarged. Far-reaching achievement can be had only through continuing close cooperation on the part of citizens, farmers, erosion specialists, and State agricultural agencies. I am convinced that we are going to have just this kind of program; and through it, I am convinced also that these fertile lands, so indispensible to the continuing welfare of South Dakota and her sister States, will be given the protection without which tens of thousands of acres cannot be preserved.

Too bad we have lost another year in quantity collection of slender wheat-grass seed. W. A. Rockie had several areas for seed collection located on railroad lands, but lost his labor just as the seed matured in June. I saw the areas, and it is most painful to contemplate what we missed. Slender wheat is an excellent grass; it looks even better than crested wheat, at least in places, and crested wheat is a wonder in the Pacific Northwest. Think of it, we went to Asia to find crested wheat, and it was a great stride forward, to be sure. But in the meantime, we have generally overlooked a native grass—slender wheat—that covered millions of acres in Washington, Oregon, Idaho, and neighboring territory. Now we have a supply of crested wheat grass seed, the parents of which came from across the Pacific, but only a handful of the seed of a grass that grew on every hand over an enormous portion of North America before it was destroyed by plows and overgrazing.

New Farm Industry

Not so discouraging, however, has been the collection program with respect to the seed of numerous other native grasses and herbaceous plants with high erosion-control potentialities. Dozens of different kinds have been garnered in quantity this season. In the S. C. S. warehouse at Gallup, N. Mex., I saw an enormous stack of sacks plump with 1935 western wheat grass seed—60,000 pounds. In a little while these seeds will be in the ground doing their part toward stabilization of America's indispensable crop and grazing areas. And, in this connection, the harvesting of these hundreds of thousands of pounds of native seeds has created a new agricultural enterprise in these areas.

Mr. Bennett standing beside a wagon which is buried by sand washed from adjacent slopes. Arroyo Grande project, California.

In conclusion, my western swing convinced me that the fundamentals of practical erosion control through the use of the soil in accordance with its needs and adaptabilities are finding their way into the everyday practice of thousands of American farmers who a little while ago looked upon the word erosion as some vague expression familiar only to academicians. In retrospect, I find it difficult to understand for why so long we permitted vast areas, including some of the most fertile lands of America, to be washed away or blown away without evidencing any considerable interest, especially when it is considered that the methods of control now being used are so simple, so practical, and generally so inexpensive. Nothing is to be gained, however, by lamenting our failure to see and meet the problem 50 or 75 years ago. Now, finally, through this national program of coordinated, practical erosion control, and through the retirement of much erodible land to stabilizing cover under the program of the Agricultural Adjustment Administration, the path ahead to successful solution of the problem is clearly marked out. This western trip, which was my first opportunity to make anything like a comprehensive inspection of the field program of the Service, has convinced me that our program is so sound, so practical, so effective, and so inexpensive that this sensible Nation will permit no obstacle to interfere with its progress. Everywhere I found that splendid cooperation was being received from the State agricultural colleges, the county agricultural agents, the farmers, and local business men.

Research Needed

We do not yet know, of course, all that should be known about how best to handle certain types of land within the various climatic and soil regions. Much experimental work remains to be done. We are finding that subsoiling is an effective measure for increasing absorption of water and thereby reducing erosion on some soils under certain types of rainfall, and of no value whatsoever under other conditions; we do not know, however, the limitations of this method of controlling erosion by increasing infiltration of meteoric waters. Nor do we know how best to handle

crop residues, such as small grain stubble, so as to leave some protective portion of the vegetation above ground in our cultural operations. Much remains to be learned about the most advantageous methods of utilizing strip cropping, which is accomplishing such an effective job of erosion control on many types of soil. It is not known, for example, how wide the strips should be on the steeper slopes or at just what declivities strip cropping should be supported by terracing.

These are but a few of the numerous things that we should know and can know only through research, or by trial and error. Without delay, these major uncertainties should be subjected to the scrutiny of research on a regional basis, in close cooperation with the State agricultural experiment stations.

Proceeding in the foregoing direction, again I want to repeat that the way to a successful solution of the erosion problem of the United States seems clear enough. The ability, enthusiasm, and energy of the field forces of the Service have been a major force, I am sure, in bringing about this infant revolution in correct land utilization. Such fine cooperative spirit as that manifested by members of the State advisory committees and the regional staffs throughout the areas we visited must have fruition. I think we cannot now turn back short of our goal of stabilizing the remaining areas of good agricultural land within a period of 25 or 30 years. The job is so big that we must call all State and community forces urgently into action as our allies, and gain the support of the entire population in eroding regions. I have no doubt about the continued cooperation of farmers and ranchmen.

EMPLOYMENT OF RELIEF LABOR

Progress in the transfer of labor from relief rolls to the Soil Conservation Service is reflected in a statistical summary issued as of October 19.

The report shows that 14 units had exceeded their quotas on that date.

State, watershed, or area	Number of relief workers	Relief labor quota	Regional director	Percent of relief labor quota
New Jersey	589	268	Lee	219.4
Kansas	548	293	Duley	187.0
New York	731	420	Howe	174.0
South Carolina	1,345	775	Buie	173.5
Pennsylvania	838	489	Patrick	171.4
Nursery	496	301	Enlow	164.8
Colorado	953	649	McClymonds	146.8
Illinois	422	337	Fisher	125.2
East Texas	556	450	Merrill	123.6
Wisconsin, Minnesota	524	431	Davis	121.6
Virginia	441	374	Keil	117.9
Georgia	917	795	Rast	115.3
Nebraska	229	200	von Trebra	114.5
Iowa, Missouri	1,091	1,068	Uhland	102.2
Oregon, Idaho				
Washington	397	405	Rockie	98.0
North Carolina	1,298	1,349	Stallings	96.2
California, Nevada	859	911	Reddick	94.3
Ohio, West Virginia				
Indiana, Michigan	912	1,020	Cutler	89.4
Maryland	152	185	Bruce	82.2
Central Texas	456	647	Geib	70.5
Navajo	903	1,296	Matthews	69.7
South Dakota, North Dakota				
Montana	540	780	Clemmer	69.2
Arkansas	582	888	Sargent	65.5
Kentucky	159	314	Alberts	50.6
Gila	678	1,389	Fleming	48.8
Mississippi	356	758	Anders	47.0
Oklahoma	412	888	Winters	46.4
Alabama, Florida	262	588	Bailey	44.6
Louisiana	262	669	Mims	39.2
Rio Grande	352	926	Smith	38.0
Maine	337	116	Patrick	31.9
Wyoming	38	370	McClymonds	10.3
Wind erosion	98	1,042	Finnell	9.4
Total	18,433	21,552	Average	85.5

Badlands of the San Simon Wash, Arizona, where erosion has taken its toll.

LIME AS A FACTOR IN SOIL CONSERVATION

By Sidney P. Armsby

Lime plays an essential part in soil conservation. Its benefits are cumulative in effect.

Quite generally soils which are noticeably acid are also markedly deficient in humus and have very little water-retaining capacity. This is particularly true in western Pennsylvania, where the soils are derived principally from the weathering of shale and sandstone. On many of the badly eroded slopes of this area we find gravelly or shaly soils, loams or silt loams practically devoid of organic matter, strongly acid, and with very little ability to absorb and retain water. Such soils are simply "floated" away by run-off water unless checked by vegetation or by artificial means.

When such a soil is limed, however, and planted to the first crop of a properly planned rotation, an important series of changes is instituted. The first visible effect of the lime treatment is a heavier growth of vegetation—corn, wheat, clover, or whatever it may be. This heavier growth, in turn, provides a larger bulk of material of a fibrous character (roots, stems, and leaves) more or less firmly anchored. Considered purely from a mechanical viewpoint, this material acts like a network of minute check dams—holding back the light soil particles and thereby retarding erosion. This retarding effect is progressive as the crop matures, because the total mass of vegetable material is constantly increasing.

Stubble to Humus

There is a larger quantity of stubble left in the lime-treated field than would have been possible had the soil not been limed, and when this decomposes, humus is produced and the water-absorbing capacity of the soil is increased. During the following season the soil will not wash so easily; crops will grow better because of the retained moisture; a larger root system will be developed by the growing crop, and this favors percolation and retention of more soil in place. Then, as season follows season—and assuming that proper replacement is made of the lime and other materials (both mineral and organic) removed in the harvested crops—the process continues at an accelerated rate, up to the point of maximum efficiency.

Development of soil acidity is prevented; larger crop yields are obtained; humus reserves are built up, and what was originally not much better than loose, powdery "dirt" often becomes a real soil—firm in texture, able to absorb and retain moisture, highly productive, and much less subject to erosion.

The value of organic matter in this connection is well illustrated by tests made on Marshall silt-loam soil at Clarinda, Iowa,[1] covering a period of approximately 18 months, during which there was a total precipitation of 40 inches. On an 8.8 percent slope a check plot in corn with no treatment showed a 15 percent run-off, a soil loss of 50 tons per acre, and a corn yield of 40 bushels per acre. A similar corn plot on the same slope, in which green sweetclover was grown and plowed under, showed a run-off of 7 percent, a soil loss of 8 tons per acre, and a corn yield of 100 bushels per acre. Thus the moisture loss was reduced over 50 percent; the soil loss, or erosion, was reduced more than 80 percent, and the crop yield was increased 250 percent.

Liming Retards Erosion

This test emphasizes the value of lime in erosion control. A soil which has been built up by crop rotation and the proper use of lime is much less subject to erosion. A good solid stand of bluegrass, alfalfa, or clover, grown in a properly limed soil, affords almost perfect protection against water erosion, even on very steep slopes.

Thus, liming the soil occupies a key position in the activities of the Soil Conservation Service. It is essential as a plant food; its correct use increases the profits from farming operations and promotes the proper use of agricultural land. And, at the same time, it serves as a valuable "tool" for use in the campaign against the farmer's arch enemy—soil erosion.

Erosion must be controlled before soil fertility can be increased.

More than 40 percent of the soil wealth is contained in the top six inches of soil.

Erosion has caused streams to dry up, resulting in the disappearance of fish, animal, and bird life.

Retiring from cultivation all badly eroded submarginal lands and planting them to either grass or timber is an effective means of securing best land utilization.

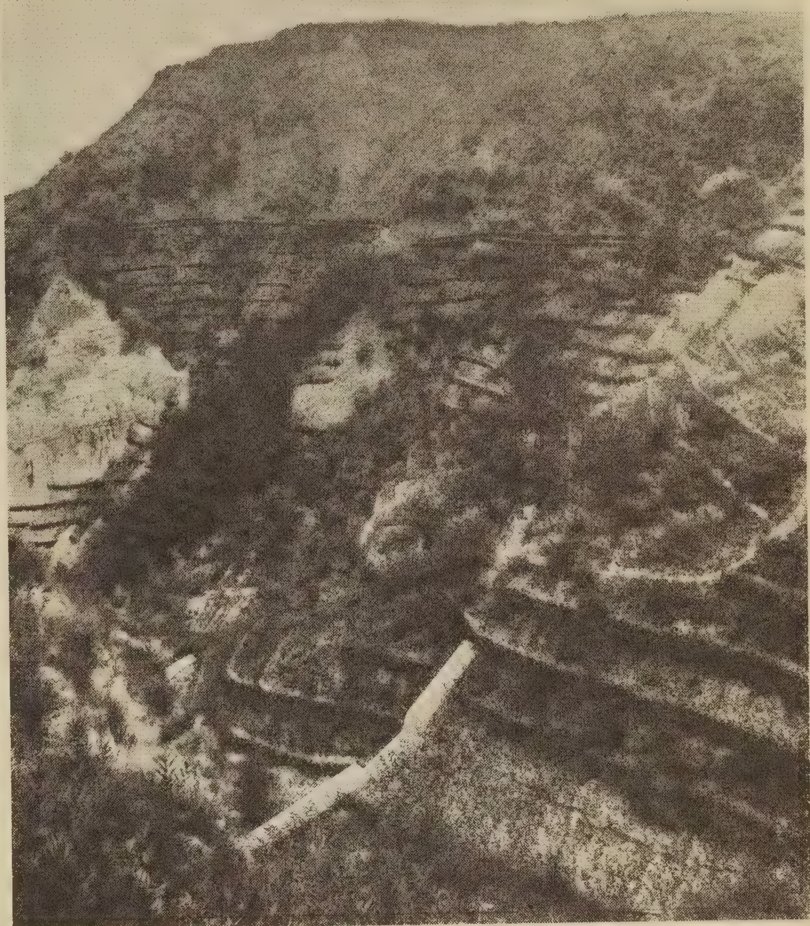
The Romans noted the folly of growing the same crops on the same land for several consecutive years.

[1] H. H. Bennett—Transactions, American Geophysical Union, 1934.

DAMS THAT GROW

By Albert Chiera

(Editor's note.—Soil science, which knows no international boundaries, finds it useful now and then to take a look into other parts of the world. In so doing, it does not commit itself to practices prevailing elsewhere but simply adds to its own treasury of information. This article, with its very interesting pictures, is a byproduct of extensive reading of erosion-control literature by the author, who is a translator and research assistant for the Soil Conservation Service)



There are two ways of checking unruly waters: By vegetation when the flow is moderate, by dams when the flow is more impetuous.

One might infer from this arbitrary statement that dams, being employed against more violent falls, would serve their purpose unfailingly unaided by vegetation. Such a conclusion would be in error.

In Italy from 1870 to 1910 the enormous expenditure of 700,000,000 lire was devoted to restraining waters by dams and other artificial methods. Only a few hundred lire went into reforestation. The results have been entirely disproportionate. G. Di Tella illustrates this fact by numerous examples of mountain streams in which dams were used unsuccessfully ("L'Alpe" Rivista Forestale Italiana; May 1931). The state of these mountain streams tells the story of the frequent failure of the dam method when unassisted by vegetation.

It often happened that dams alone were rendered useless by being covered up by materials washed from the mountain sides. New masonry dams were built, and vegetation was established on the side slopes, to resist scouring by erosive waters and to prevent slides.

First of all, the slope which was originally rough because of erosion was graded and made even, so that the water might spread and flow smoothly, gently down the sides. Wattled or willow dams and fascines were then set in diagonal and horizontal lines across the slope.

The pictures point to the success of the plan. It shows the watershed at the right of the torrent Cava Fasaniello, in the Province of Naples, partly restored

(Continued on page 13)

THE PICTURES

Opposite page, top.—*A view of the torrent Cordarezzo, near Piacenza, showing the inability of dams unsupplemented by vegetation to bind the earth in this region. Slides and debris have all but obliterated the masonry structures and have rendered them useless in erosion control.*

Opposite page, bottom.—*Another view of the Cordarezzo, after engineering treatment of the mountain slope for the establishment of fascines and wattles, and renovation of the series of dams.*

This page.—*A lattice work of live willow branches, thrifty and well established within the short space of 4 months, holding soil in place, assisting other vegetation to obtain a foothold, keeping run-off water from rushing down the slopes to wreak such destruction as that shown in the top picture on the opposite page.*

DETENTION RESERVOIRS FOR GULLY CONTROL

By Dwight D. Smith and Emerson Wolfe

Due to the fact that large gullies exist on comparatively small drainage areas in the Big Creek watershed in Missouri, it soon became apparent that the cost of the conventional type of masonry and cement structures could not be justified on an acreage basis. Since the amount of water to be handled was comparatively small, it was thought possible to design a detention reservoir which would be capable of storing the run-off from the average hard rain and discharging it slowly to the bottom of the gully.

Meeting the Problem

An earthen dam with a small tile drain supplemented by an emergency side spillway at a higher level seemed a good solution to this problem. In order correctly to design these structures, rainfall data including amounts and intensities for this area were consulted. From this the required storage capacity and the necessary rate of discharge from the tile drain were determined. It was decided to design a detention reservoir so the emergency side spillway would be used on an average of about once in 2 years. This period of time allowed economical construction and seemed ample to enable vegetative protection to establish itself. Another factor in favor of this type of structure was the high clay content of the subsoil of the Grundy-Shelby series on which we were working. Also, machinery was available to move earth econom-

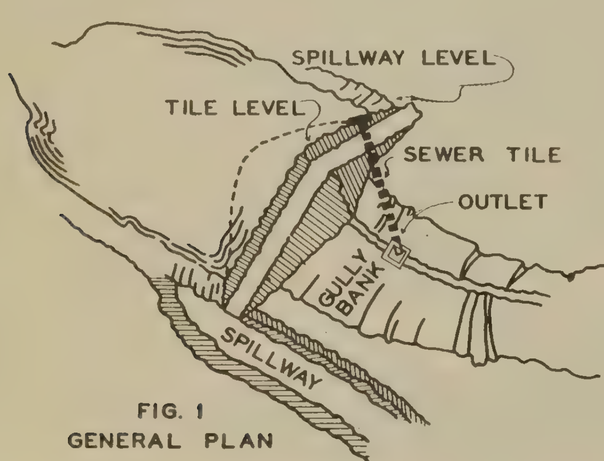


FIG. 1
GENERAL PLAN

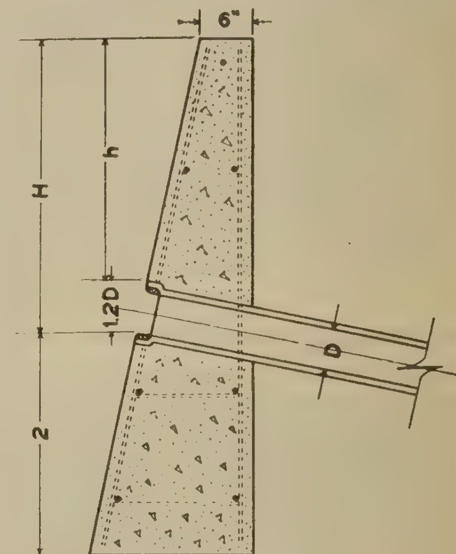


FIG. 2
INLET PLAN

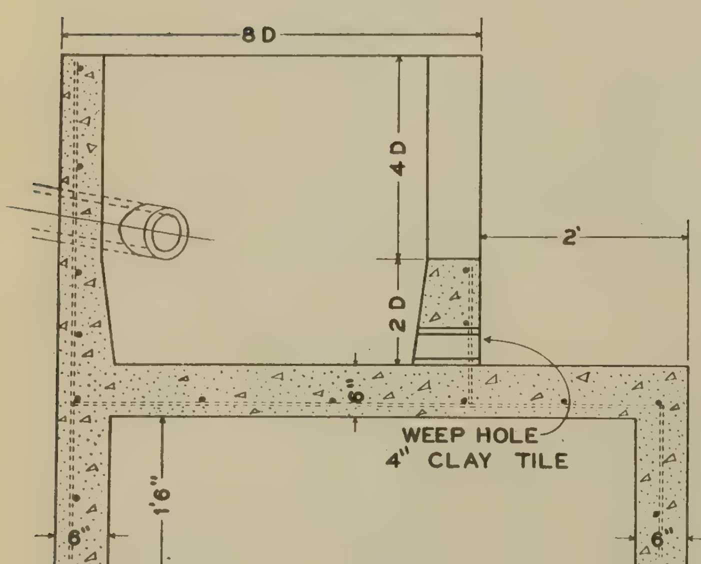


FIG. 3a

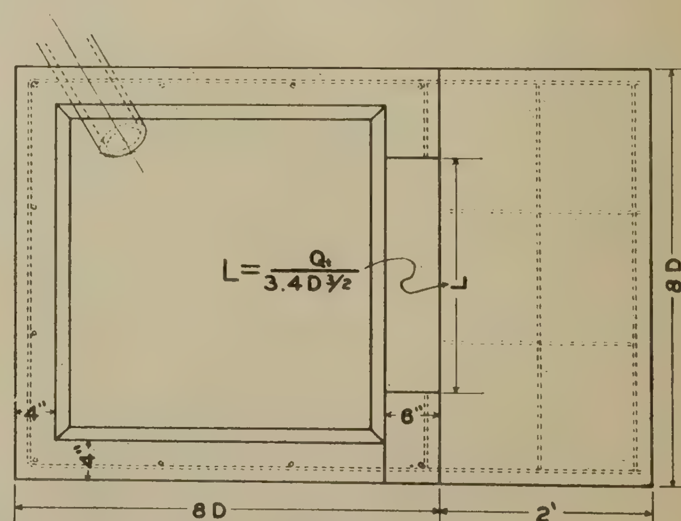


FIG. 3b

OUTLET PLAN

ically. This is an important factor and may influence the design or even make the use of some other type of structure more practical.

In general, the method of construction of the dam proper follows conventional practices. Whether or not the dam is constructed before the tile is laid will depend upon the individual problem at hand. If the dam is to be several feet higher than the inlet to the drain it is usually best to put the tile in place first. If it is to be only a few feet higher than the inlet, the tile is best installed after the dam is built in order to eliminate the danger of damage or breakage of the tile during the construction of the dam.

Adequate Storage Capacity

The dam and the emergency side spillway must be enough higher than the existing overfall in the gully to provide adequate storage capacity. The tile drain is best located at one end of the dam on solid ground. (See fig. 1.) The emergency side spillway must be large enough to handle the maximum run-off from the drainage area and should be protected by an adequate vegetative cover. Sewer tile, laid entirely on solid ground, with joints cemented or packed with treated oakum and asphalt, has proven to be the most satisfactory drain, cost considered. The tile should be laid on an even grade and cradled to at least the quarter point. All changes in grade should be made on a vertical curve. Seep collars around the tile should be provided where it is thought necessary to prevent seepage working down along the tile line.

The inlet consists of a reinforced concrete headwall with a bell-mouthed orifice to reduce entrance loss into the tile. (See fig. 2.) Several types of outlets have been used and each utilizes a water cushion as a means of destroying the velocity of the water. Figure 3a shows a cross-sectional view and figure 3b shows a top view of a type of outlet design.

The size of the drainage area is one of the limitations of these structures and is relative to the available storage capacity. Storage capacity must be obtainable without too great a height on the dam. The soil type must be adapted to earthen reservoir construction. These dams are more satisfactory on pasture or terraced drainage areas where the rate of silting is low.

The engineering section on the Big Creek demonstration project has workable formulas for computing the storage capacity needed and the discharge rate required.

OREGON DUST SPOTS LOCATED BY PLANE PILOTS

Aviation has added its plea for wind erosion control. Pilots of airplanes flying between Pendleton and Portland, Oreg., have reported the impossibility of landing at times, owing to dust. With ground winds at 15 miles an hour or higher, these pilots have observed that most of the dust blowing comes from 10 or 12 spots easily identified from the air. The greater part of this dust, they have stated, comes from areas other than cultivated farm land.

Business men have joined with air lines in asking that the Soil Conservation Service survey "blow" areas in northern and central Oregon with a view to curbing the dust storms which make plane landings hazardous and living conditions unpleasant.

DAMS THAT GROW

(Continued from page 11)

by vegetation of only 4 months' growth. At the summit the work must yet be completed.

A detailed description of the way in which this work is actually done is given by C. Valentini in his book Control of Torrents and Mountain Basins. He offers some suggestions as to the construction of these wattles or fascines intended to protect vegetation during its early stages.

"Wattles" are built by driving in the ground green willow stakes that are expected to germinate and are arranged as a palisade. This forms the frame of the living dam which is interwoven with long willow branches in the same manner as a basket. They are generally about 20 inches high and placed at suitable intervals apart. Each structure is defended against the impact of run-off waters by a small earthen bank placed in front to support it; over this bank shoots of willow are also planted. Between successive willow dams are planted shoots of elm, ash, and maple.

When higher dams are required, the stakes are of larch or of species equally strong. For plants intended to sprout, when willow is not available, recourse is taken to spruce, hazel, and alder.

"Fascines" are very similar to wattles, with one difference. Instead of the branches being interlaced, they are bunched and tied together and then laid back of the palisade, thus forming the fascine.

Excess water not absorbed by vegetation is carried off in sluiceways to the foot of the slope. These are protected against water erosion by stones.

PLANTS OF PROMISE IN GULLY SLOPE PROTECTION

By Henry E. Collins

Gila River Project, Safford, Ariz.

Cactus plants set above brush riprap. Easily transplanted in desert washes, they serve a useful purpose in collecting silt.

On the upper Gila River watershed erosion is so severe that climax vegetation is insufficient to reestablish a cover. The year's precipitation, averaging 12 inches or less, is largely confined to winter and midsummer, following three months of extremely dry weather in the spring. Torrential summer downpours have caused a badly gullied condition and washed off much of the top soil, allowing invasion of the slopes by plants of low value in producing forage and controlling erosion. One of these plants is *Haplopappus sp.* (Jimmyweed) and others are *Gutierrezia spp.* (Snakeweed) and *Opuntia stanleyi* (Devil cactus).

It is apparent under such conditions, as for instance the deeply creased San Simon Valley, that an important move in erosion control is slope protection. Alone or in conjunction with mechanical methods, the reestablishment of vegetation along the banks of gullies and streams is of prime importance.

Fortunately, there are available a number of plants of heavy root system and rapid growth which may be easily established. The extreme conditions prevailing and the urgency of effective control, suggest the use of plants which may be readily established irrespective of their value for other purposes.

The following findings, although covering a comparatively short period and specific conditions, indicate what may be expected. Of outstanding significance is the fact that fall and winter transplanting gave most generally satisfactory results because of the greater precipitation and less evaporation which occur at these seasons. It was also found that best results in check dam plantings were had after one summer of filling.

Tamarix gallica (salt cedar).—This species, found growing abundantly along the Gila and Salt Rivers, is now becoming established in the washes in the San Simon Valley. It is being used successfully as bank protection by a railroad along the Little Colorado River in northern Arizona. The plant is browsed by stock to some extent but recuperates rapidly and withstands being covered by silt. Although rather drought resistant, it does not propagate and spread readily unless favored by underground moisture. The fact that it propagates readily from cuttings and makes a rapid growth should make it valuable for stream and large wash bank protection.

Thirty-six rooted cuttings were set in the main drainage canal of the San Simon Valley March 27, 1935, with a loss of only 10 percent. Also several

rooted cuttings were planted behind check dams on the erosion-control projects of the Papago Indian Reservation in the fall of 1934 with good results. Unrooted cuttings have also been grown successfully.

A Fast-Growing Tamarisk

Tamarix aculeata (Athel tree).—This tamarisk is much faster growing than gallica. It also is browsed to some extent by cattle and attains sufficient size to furnish firewood and posts. Like the salt cedar, it propagates readily from cuttings and, with its heavy root system, is equally satisfactory for bank protection. It is, however, less hardy, which restricts its use to the warmer areas.

Out of 300 cuttings, varying in size from very small ones to 3 or 4 inches in diameter, set out on the San Xavier Indian Reservation in January 1935, about 95 percent grew successfully. These cuttings were planted behind check dams in small gullies.

Baccharis glutinosa (Bata mote).—This medium-size, fast-growing shrub also appears to have an important place in stream-bank protection and in gully work where there is some accumulation of underground moisture. The plant is found in large quantities along the Gila River and is becoming established in the San Simon wash. It propagates readily from cuttings or rooted transplantings and withstands flooding, but is only sparingly browsed by stock.

Of 3,000 rooted cuttings planted behind check dams on the San Xavier Reservation in January 1935, about 90 percent grew successfully. On March 27, 1935, 36 cuttings were set in the San Simon wash, of which 85 percent are growing.

This Is Easily Transplanted

Aster spinosa (Spiny aster).—This stoloniferous perennial transplants readily, is deep rooted and withstands heavy flooding and silting.

In a planting of 3,000 rooted cuttings set behind check dams on the San Xavier Reservation during January 1935, about 90 percent grew satisfactorily. Out of 30 rooted cuttings set in a diversion canal near Safford on February 28, 1935, 75 percent are growing as are 36 cuttings set in the San Simon wash.

Chilopsis linearis (Desert willow).—Desert willow is common in large desert washes within its altitude range. It is effectively checking erosion here, as well as in steep canyons. Although not classed as a grazing plant, the spring foliage is eaten by stock. Young seedlings and rooted cuttings transplant readily, and the plant is considered of outstanding value for gully-erosion control.

One hundred and thirty-four rooted cuttings were set out behind erosion structures in gullies in January of this year, 110 of which are growing. Of 150 transplantings in the diversion dam area near Safford last December, 90 percent have become established.

Clematis drummondii (Silk vine).—This woody vine is a rapid grower. In many cases it is proving effective in checking gully erosion. It is tolerant of shade but is often found in exposed situations. That it may be readily transplanted is indicated by the fact that of 100 plants set behind check dams at San Xavier in January 1935, no loss was sustained.

Hymenoclea monogyra (Burro brush).—Common in desert washes and foothill canyons, this is effectively controlling erosion and in some cases actually causing gullies to fill with silt. The plant may be grown readily from uncalloused stem cuttings or seed. Numerous test plantings along gullies, from cuttings, were entirely successful.

Black Willow Binds Well

Salix nigra (Black willow).—Several large, post-size cuttings of black willow were used as binders for check dams near Artesia, Ariz., in the fall of 1934, most of which are growing. Thirty-six stem cuttings were set in the San Simon wash and 25 in the Freeman wash in the spring of 1935, with a 50 percent catch. Even where post-cuttings fail to take root they have been found to last 3 to 4 years.

Capriola dactylon (Bermuda grass) is found to be coming in from seed behind erosion control structures, both on the Papago Indian Reservation at an elevation of 2,500 feet and near Safford at an elevation of 3,900 feet. Root transplantings, in the San Simon wash and in Freeman Flats, took hold and are spreading.

Holcus halepensis (Johnson grass).—This grass was established on the Papago Reservation in the desert washes by seed sown in November 1934. A large-scale experiment, made by a rancher near Tucson, was successful in establishing this grass from root cuttings with the aid of contour furrows.

Johnson grass is common along the Gila River and all adjacent irrigation canals. Consequently, infestation has ceased to be a potential threat in this area.

(Continued on page 16)

KUDZU AIDS IN GULLY CONTROL

Claude C. Hamilton, who lives on the old family farm nine miles northeast of Forrest City, Ark., finds kudzu effective in gully control.

In 1923 a single crown of kudzu was obtained from Alabama. It was transplanted near a wide and deep gully near the farmhouse and just across the road from his large peach and apple orchard. The vine began to grow and spread. It now lines the gully and covers its bed to a distance of 100 feet. It has climbed trees near by and threatens to kill them. The road grader seems to be responsible for keeping the kudzu cut back and protecting the peach trees on the other side of the road.

Mr. Hamilton said that the kudzu vines have gone through at least three fires and have survived and spread and vegetated the gully despite these destructive agencies. Although the gully is still about 15 feet deep, it is rapidly being stabilized by the cover vegetation.

Kudzu is a leguminous plant which endures poor soil on badly eroded areas. Under usual conditions, it grows fast and the foliage is so dense that one season's growth goes far toward controlling erosion. Conservation specialists set the crowns around the rim of a gully and behind the check dams. The vines will usually grow down the banks and affix themselves over the entire face and channel.

Kudzu vine may be used moderately for grazing. The foliage is of high protein content and is relished by livestock.

Growth of kudzu from single crown planted on the Hamilton farm in 1923.

PLANTS OF PROMISE IN GULLY SLOPE PROTECTION

(Continued from page 15)

Atriplex canescens, *A. polycarpa*, *A. lentiformis*, *A. linearis* (salt bushes) have proved in past experiments to be fast growing from seed when planted in flood plain areas in the Southwest. Seeds of these plants are usually viable and are easily gathered. All salt bushes are browsed to some extent by stock and the large root system is ideal for gully erosion control. Seeding experiments, in the Freeman Flat area and on the Papago Reservation, indicate that the plants can be readily established by direct seeding.

Valota saccharata (cotton top), *sporobolus airoides*, (Sacaton) and *Andropogon saccharoides* (feather grass) usually give a high percentage of viability in germination tests. With the additional moisture made available by check dams, indications are that these grasses would become established by direct seeding.

One thousand sod clumps of each of these grasses were set behind erosion-control structures on the San Xavier project in January 1935, and at present 95 percent of each have become established. Both the cotton-top and sacaton grasses are considered excellent feed and observations indicate that these grasses would grow under all conditions found on the San Simon watershed.

U. S. GOVERNMENT PRINTING OFFICE: 1935

A. General	Total
Number of private-land projects in operation to date	131
Number of Federal-land projects in operation to date	4
Acres in private-land projects	6, 871, 029
Acres in Federal-land projects	39, 720, 000
Number of farms in area	39, 675
Number of trainees at end of month	91
Number of C. C. C. camps	447
1. Farms put under agreement	12, 317
2. Acres in farms now under agreement	1, 652, 518
3. Agreements canceled	213
4. Acres in farms on which agreements canceled	28, 154
5. Percentage of farms in project areas under agreement	31. 0
6. Percentage of total area under agreement	24. 1
7. Number of acres completed by the detailed erosion survey	6, 054, 381
8. Number of acres yet to be surveyed on all farms under cooperative agreements	208, 581
9. Number of acres yet to be surveyed on farms under cooperative agreements where forest or other nontilled areas have not yet been mapped	75, 638
9a. Acres yet to be completed by the detailed soil and erosion survey	15, 578, 524
10. Number of acres on private-land projects needing treatment	1, 689, 653
11. Acres on private-land projects for which no special erosion-control practices are planned	329, 621
12. Number of acres under treatment and finished	1, 211, 702
13. Number of farms with treatment finished	3, 112
14. Number of acres on which treatment is finished	580, 863
15. Number of invitations received from farmers to make agreements	14, 753
16. Number of acres in farms for which invitations are received	2, 047, 123

B. Data on farms under agreement	Total
17. Acres strip cropped before contract	6, 444
18. Acres agreed to be newly strip cropped under contract	310, 858
19. Acres actually newly strip cropped	190, 535
20. Acres contour tilled before contract	229, 148
21. Acres agreed to be newly contour tilled under contract	458, 838
22. Acres actually newly contour tilled	251, 380
23. Acres terraced before contract	143, 784
24. Acres agreed to be newly terraced or reterraced under contract	388, 308
25. Acres on which proper rotation practiced before contract	149, 358
26. Acres on which proper rotation newly agreed under contract	626, 527
27. Acres on which proper rotation actually newly followed	453, 809
28. Acres contour furrowed before contract	2, 472
29. Acres agreed to be newly contour furrowed	57, 990
30. Acres actually newly contour furrowed	26, 704
31. Acres in cultivation before contract	901, 774
32. Acres agreed to be taken out of cultivation	138, 241
33. Acres actually taken out of cultivation	103, 690
34. Acres agreed to be retired to permanent hay and pasture	112, 831
35. Acres agreed to be retired to forest	41, 293
36. Increased acreage erosion-resisting crops agreed	189, 139
37. Decreased acreage clean-tilled crops agreed	107, 494

REPORT ON PROJECT PROGRAMS TO SEPTEMBER 30, 1935

C. Engineering	Total
38. Miles of terraces constructed	13, 506
39. Acres protected by terraces	153, 203
40. Number of permanent terrace outlet structures completed	30, 079
41. Number of temporary terrace outlet structures completed	48, 868
42. Square yards of terrace outlets seeded and sodded	4, 011, 406
43. Linear feet of terrace outlet channels completed	2, 873, 380
44. Number of temporary dams, gully control, constructed	281, 236
45. Number of permanent dams, gully control, constructed	[1] 86, 549
46. Square yards, bank sloping, gully control, constructed	6, 519, 494
47. Linear feet diversion ditches, gully control, completed	[1] 1, 133, 991
48. Acres drainage area of gullies controlled	366, 337
49. Cubic yards of fills in earth dams	1, 862, 109
50. Linear feet of water spreading dikes	311, 724

D. Forestry	Total
51. Acres planting, forestation	22, 069
52. Acres planting, gully planting	18, 799
53. Square yards planting, bank protection	24, 164, 224
54. Man-days nursery work and plant collection	91, 360
55. Seed collections, hardwoods, pounds	307, 297
56. Seed collections, conifers (cones), bushels	6, 305
57. Forest management, forest under management, acres	[1] 178, 652
58. Forest management, woods pasture fenced, acres	[1] 41, 857
59. Forest management, timber estimating, forest types, etc., acres	556, 616
60. Forest management, improvement cutting, acres	3, 991
61. Forest management, number demonstration plots	311
62. Number of cooperators, wild life management	[1] 1, 983
63. Rods fences constructed	403, 214
64. Acres fire-hazard reduction	21, 806
65. Man-days fire control	5, 320

[1] Revised.

ADDITIONAL REGIONS ESTABLISHED

Since announcing in the October issue the designation of Regions 1, 2, 4, and 8, the following additional regions have been established:

Region 3, Ohio Valley region.—Tennessee, Kentucky, Indiana, Ohio, and Michigan. Headquarters tentatively located at Zanesville, Ohio; regional conservator, J. S. Cutler.

Region 6, Southern Great Plains Wind Erosion region.—Portions of Texas, New Mexico, Oklahoma, Colorado, and Kansas, as delineated on the approved regional map of the Soil Conservation Service. Headquarters, Amarillo, Texas. H. H. [illegible]

Region 10.—California and Nevada, except that part of the Virgin River drainage within Nevada. Headquarters tentatively located at Santa Paula, Calif.; regional conservator, Harry E. Reddick.

Region 11, Northwest region.—Washington, Oregon, Idaho, and that part of Montana west of the Continental Divide. Headquarters tentatively located at Spokane, Wash.; regional conservator, W. A. Rockie.

SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE · WASHINGTON

DECEMBER 1935

Dr. Lowdermilk Presents in This Issue His Plans for Soil Conservation Research

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WELLINGTON BRINK EDITOR

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

H. H. BENNETT
Chief, Soil Conservation Service

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SOME ASPECTS OF RESEARCH IN THE SOIL CONSERVATION SERVICE

By W. C. Lowdermilk

Associate Chief, Soil Conservation Service

Dr. Lowdermilk.

Research by the Soil Conservation Service in erosion and its control is authorized by the Soil Conservation Act (Public, No. 46, 74th Cong.), and by the Secretary of Agriculture's memorandum of March 27, 1935. In the meaning of this act, wherein Congress recognizes that wastage of soil and moisture resources by soil erosion is a menace to the national welfare and that it is the policy of Congress from now on to provide permanently for the prevention and control of soil erosion and further, wherein Congress has authorized the action taken by the Secretary of Agriculture to coordinate agencies within the Department of Agriculture to effect the purposes of this act, the Soil Conservation Service has a mandate to undertake a program of comprehensive research into the "character of erosion and needs for its control." In approaching such a task, soil erosion control is considered on a long-time basis as a constructive measure in national economy.

The character of erosion implies first, the erosional processes which have been in operation for thousands of years under prevailing climatic controls, land uplift and under the restraint and interaction of a coverage of natural vegetation. There have developed for each physiographic and climatic region definite responses to the forces of soil formation and land planation which have resulted in the form of landscape and in the formation of soil profiles. The rate of erosion by wind and water under undisturbed conditions represents a geologic norm of erosion, and would furnish, when discovered, a base line of natural process from which would be measured the degree of acceleration of erosion as a result of agricultural occupation with herds and by the cultivation of fields. This geologic norm of erosion varies from region to region and marks the limit of effectiveness of possible erosion control measures. The law of diminishing returns furthermore may make it economically impractical to reduce soil erosion under land cultivation to this geologic norm.

The needs for the control of erosion can best be set forth by considering the present and future requirements of the Nation and the rate of wastage of soils under present forms and practices.

The Continental United States is the homestead of the American people. No new continents await discovery, exploration, and occupation. The fact must be faced that the American people will derive its essential sustenance from this land area now and in the

A shallow, flat-bottomed terrace outlet ditch protected by spreader boards and bluegrass, on the experiment station near Bethany, Mo.

A series of run-off and soil-loss measuring units, located along terraces of experiment station near Clarinda, Iowa.

A series of run-off and soil-loss measuring units located on an exceptionally steep slope of the soil erosion experiment station, at Pullman, Wash.

future. When on November 26, 1934, by Executive order, the remaining public domain was withdrawn from further homestead entry, an era in American history was brought to a close, an era of land occupation. The good lands of the Nation are settled, and the best lands have for the most part been cleared and cultivated. Accordingly, it is fitting that we take stock of this occupation, and its effect on our land resources.

A Useful Survey

The erosion reconnaissance carried out by the Soil Conservation Service in 1934 was such a stock-taking. The results of this survey are known. Suffice it, to call attention to the fact that within the past century the American people have engaged in a huge operation in soil mining. This exploitation which has been common in the past to agricultural occupation in other lands has resulted in soil wastage and depletion on an enormous scale in the United States. An area fully the size of Kansas has been ruined for further cultivation by the riddling, incising and excavating work of gully erosion. Still more portentous is the truncation of soil profiles by sheet erosion, whereby more than one-half of the topsoil has been washed from more than 125,000,000 sloping acres of good land. And wind erosion has made useless for cultivation nearly 10,000,000 acres.

Only about 75,000,000 acres are level or approximately so, on which the water erosion hazard is low. But fully 365,000,000 cultivated acres within humid to semi-humid climates are required to supply the food and fiber requirements of the American people. The major agricultural production of the country must therefore be had from sloping lands, all of which are susceptible to wastage from water erosion, unless adequate measures and practices are followed to reduce, control, and prevent soil erosion.

Research Essential

So rapid is this wastage of soil resources that the trial and error method of long experience is altogether too slow to meet the urgent needs for the development and practice of erosion control measures. Only by systematic investigations, experimental studies, planned and operated in accordance with the principles of scientific research, will measures be discovered and tested promptly enough to save enormous values in agricultural lands. In few enterprises is research more necessary or more urgent. Increasing population and rising standards of living make more imperative these demands upon production capacities of soils.

Erosion by water action is a geologic process of long standing; it is older than sedimentary rocks, is as old as the first rainstorm. Landscapes have been sculptured under the protecting influence of natural mantles of vegetation, except, of course, in desert areas. Despite this geologic norm of erosion, soils have accumulated in valleys and on slopes under dependent coverages of vegetation. Such norms of erosion have not generally proceeded at rates in excess of soil formation—a most important fact.

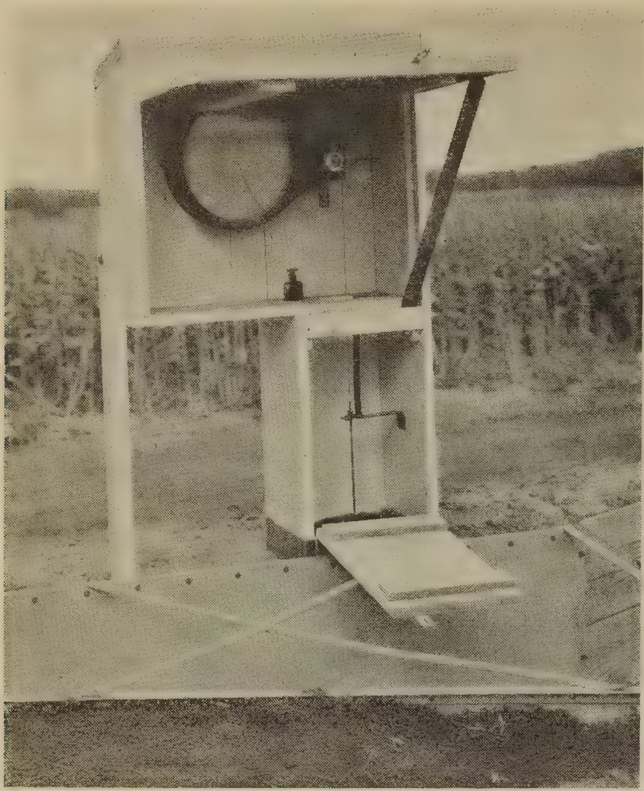
Destructive Process

When the natural mantles of vegetation are removed, or cleared as by heavy grazing or cultivation, soil surfaces are exposed to the full force of wind and flowing water. Erosion of an accelerated order is introduced. This man-induced or accelerated erosion has been found by quantitative measurement to exceed on sloping lands rates of soil formation—a sure process of soil destruction.

Agricultural practices inducing such acceleration of erosion are nothing short of self-destructive; they are suicidal, as extensive areas of devastation and barrenness in once-flourishing regions proclaim to the observer. Crops must be grown, whether or no the methods employed safeguard the soil resource. We can be provident only when in possession of a certain abundance of resources. For a starving farmer will eat his seed grain. Problems of sustained productivity are thus forced upon the Nation by the headlong rate of erosional wastage.

Debris Creates Problems

Along with wastage of the soil itself go other problems arising from soil erosion. Debris is washed off sloping fields and excavated out of yawning gullies to be sorted by flowing water into clays and fine silts which are carried into streams and finally into the ocean or land-locked basins, and into coarser material and sands which are lodged on the way in drainage channels. These accumulations and deposits occur as overwash on fertile fine-textured bottom lands, as shoals in streams and silt deposits in artificial reservoirs. Erosional debris thus impairs the utility of water resources, for navigation and for municipal power and irrigation supplies. And still further, the



Close-up of instrument shelter house, water-level recorder and flume, as installed on soil erosion experiment station at Hays, Kans.

conditions of reduced absorption of precipitation waters and rapid accumulation of surficial run-off into runnels, streamlets and "gully washers" increases the rate and amount of storm run-off and thereby accentuates flood peaks and damage. Such flows discharging into stream channels whose cross-sections are reduced by shoaling of erosional debris, more frequently overtop and spread beyond stream banks as floods.

Wind Takes Toll

Wind erosion, evidenced by spectacular dust storms, although causing damage to large areas of the Great Plains region, is neither as general nor as serious a national problem as water erosion. Yet, in the western Great Plains it confronts agriculture as a menace to continued productivity of extensively populated regions. Wind erosion of bared plains soils during drought years, sorts the soil much as does water erosion. The fine and fertile particles are carried aloft in dust storms and swept far beyond the area of origin. Coarser particles are left behind to form hummocks, incipient and permanent sand dunes. Extensive areas are thus seriously depleted in value and productivity.

Adequate solutions to such problems of sustained utility of the land, involving a wide variety of interacting factors, must rest upon thorough diagnoses of situations, region by region, and upon an evaluation of component factors. Farming experience has developed, under some circumstances, safeguards in soil conservation. Yet the land generally is exposed to increasing wastage for want of adequate measures or general application. At best the solutions when conditioned by physical, biological, and economic laws, call for a well-grounded program of scientific studies in which past practices will be tested, adapted, and confirmed, as well as the development of new measures.

Many-Sided Program

Such a program includes analyses of the factors of climate, soil formation, plant succession, disposal of supplies of precipitation water by evaporation, infiltration, transpiration, subsurface drainage, surficial flow, and stream discharge under agricultural practices. Then follows the isolation of variable factors through a well-planned series of experimentation capable of mathematical analysis. As variable factors are measured one by one, practicable measures take form in a progressively perfected hypothesis, until finally the hypothesis agrees with experimental findings.

Applicability and feasibility of indicated measures must further rest upon a series of experimental studies

Panoramic view showing young oats and clover, experiment station near Clarinda, Iowa.

in measures of erosion control and prevention under different conditions of cropping and cultivation. Limits of safe gradients for clean-tilled crops will be established region by region, for soil series and types, and for characterictics of precipitation in seasonal distribution, amounts, and intensities. Areas of safe cultivation against wind erosion will be delineated by soil types under conditions of periodic dry seasons and prevailing seasonal high winds. Rotations and alternations of clean-tilled and close-growing crops, which conserve soils and water, will be confirmed or discovered. Improvements in the absorption of water in rate and quantity by soils will be discovered in soil-management practices, usually in conjunction with improved fertility and productivity. Measures of improved water conservation and control will be established and developed. Agricultural practices, and soil management measures contributing to safeguarding water resources for municipal supply, power, and irrigation will be indicated. All such findings would contribute to the achievement of the objective of the Soil Conservation Act and the policy of Congress—"* * * to preserve natural resources, control floods, prevent impairment of reservoirs, and maintain the navigability of rivers and harbors, protect public health, public lands and relieve unemployment * * *"

Provisional Plan of Study

The achievement of these objectives, within a reasonable length of time, as set up by the National Resources Board, in its report of 1934, namely, within 10 years on seriously eroding areas and within a generation throughout the agricultural areas of the Nation, requires that studies be carried forward in accord with a national program of erosion prevention and control research. Such a program cannot be formulated immediately; it will require full collaboration of authorities of State, Federal, and endowed institutions in soils, agronomy, agricultural engineering, woodland management, human geography, and related fields. Fully a year, and possibly a longer time, will be required for the formulation of the general program, which is to be correlated with investigations of other departmental bureaus. Steps are being taken toward preparation of a provisional program which will be submitted to competent agencies for review and constructive criticism.

Responsibility for the research activities of the Soil Conservation Service are lodged in the Division of Research, for the present under the direction of the Associate Chief of the Service. The work of the division has been broken down into five major phases to facilitate direction and supervision, and to secure the best results from the special training and capacities of the research staff.

These phases are the following:

1. Climatic and physiographic studies.
2. Erosion control investigations.
3. Sedimentation and hydraulic investigations.
4. Watershed and hydrologic studies.
5. Economics of erosion and its control (cooperating with Bureau of Agricultural Economics).

Four Lines of Attack

1. Climatic and physiographic studies follow the general recommendations of the Science Advisory Board appointed by the President from the National Research Council. Under this section four general lines of attack are undertaken. They are:

(*a*) Climatic investigations and analysis will be planned to determine the general role of climate in its various manifestations on the processes initiating soil erosion.

(*b*) Ecological research includes studies of the role of natural or artificially established plant communities and their migration and succession in the problem of soil erosion and its control.

(*c*) Geomorphological research includes studies of the complexes of land forms and processes of denudation and erosion, as a geologic process, which bring about regional differences in soil wastage.

(*d*) Studies in erosion history include the reconstruction from historical records of the original condition of landscapes prior to intensive agricultural occupation, as a means of evaluating the trends in past agricultural land use, and the possible future trends in land use as conditioned by induced erosion.

Experiment Stations

2. Erosion control investigations are centered chiefly in the system of regional experiment stations for agricultural lands, which were established beginning in 1929 by H. H. Bennett in the Bureau of Chemistry and Soils and transferred to the Soil Conservation Service in April 1935. These investigations include four major phases:

(*a*) Nature and degree of erosion as conditioned by slope gradient, slope length, soil series and types, distribution and intensities of precipitation, condition

Terraces with light covering of snow, on soil erosion station near Clarinda, Iowa.

of soil coverage of various crops and combinations of rotations, and the physical and biological factors influencing erosion and loss of precipitation waters by surficial run-off. Such studies are generally carried out on experimental plots and fields and in lysimeters. This information is being established at 13 existing erosion experiment stations for a number of representative agricultural regions of the United States.

(*b*) Methods and measures of erosion prevention and control on agricultural pasture and woodland areas, as effected by suitable and adaptable agronomic rotations of crop combinations, measures of increasing organic content of soils and their favorable structure, cultural practices on contours, and strip cropping, broad-base terraces, bench terracing by means of permanent strip cropping, by measures of gully control such as check dams and revegetation, by measures of spreading flood waters in the alluvial plains of the west, and related methods.

(*c*) Rebuilding of soils depleted by erosion. Only a beginning has thus far been made in this phase of agriculture. Such measures when developed and applied will restore productivity on large areas of formerly good lands now generally stripped of topsoils by sheet erosion.

(*d*) Reclamation to useful crops of pasture and forests of areas ruined for further cultivation by gully erosion.

Sedimentation Studies

3. Sedimentation and hydraulic studies will establish information and carry forward studies of the processes and rates of erosion-debris transportation and deposit. Such investigations are grouped under—

(*a*) A Nation-wide investigation of storage reservoirs to provide an accurate record of reservoir sedimentation and rate of storage depletion as it affects utility and longevity of water supplies. This work involves reconnaissance examination and report on all important reservoirs in the country. Detailed reservoir studies will establish information on factors involved in silting, rates of silting as related to different slope, soil, and climatic conditions, to be correlated through other sections of research and agencies with land-use and erosion-control practices in tributary drainage areas.

Men taking samples of flow through divisor box and weir, to obtain correction factor; silt-sampler below unterraced area. Silt box is 40 feet long, 3½ feet deep at weir, and constructed out of contact with soil. Statesville, N. C.

(*b*) Investigations will be made of conditions and processes of sedimentation in minor stream channels and valleys, resulting from accelerated erosion of tributary upland areas.

(*c*) Hydraulic laboratory investigations will include studies of factors affecting the energetics of debris-laden water, the wear of debris in course of stream transportation, specific field-construction problems, development of new erosion- and flowage-control practices, and experimental application of results to full-scale engineering problems of gully and arroyo control in the field. This work includes the development of new special-purpose measuring and sampling apparatus and field surveys of prototype conditions that present the problems to be investigated by model experimentation in the laboratory.

(*d*) Factors of bed-load transportation in natural streams will be studied by direct measurement with new type installations to be placed at selected sites on tributary streams in different type regions of the country.

Watershed Studies

4. Watershed and hydrologic studies will be centered in a series of experimental watershed areas where the objectives are—

(*a*) To determine the effect of land-use and erosion-control practices on the conservation of water for crops and water supply and upon the control of floods upon conditions prevailing in typical agricultural regions. Ten such studies are contemplated.

(*b*) To determine the effect of land use and erosion control practices for small and large areas and to trace variations in this effect from plots through a series of intermediate watersheds to the largest watershed of the experimental area.

(*c*) To determine the rates and amounts of run-off and eroded material for precipitation of different amounts and intensities for typical watersheds, of different configuration, size, shape, topography, cover, underground conditions, land-use, and erosion control practices. To furnish data needed for the design of erosion control structures.

Economic Aspects

5. Consequences of unrestrained erosion and of measures of erosion control, as reflected in the economic status of farming operations on farms within project areas, will become the object of studies in cooperation with the Bureau of Agricultural Economics. The purpose of these studies is to furnish the basis of comparison of the economic as well as social conditions on demonstration projects, at the inception of the program of erosion control and at the end of the 5-year period covering cooperative agreements with farmers.

These are some of the major outlines of investigations to be conducted by the Division of Research of the Soil Conservation Service to furnish a factual basis for the planning and conduct of erosion control operations and in their progressive refinement in keeping with the adaptabilities of land, with the requirements of safe land use, and with adjustments to economic demands and considerations.

Division of Research

Direction of research is provided for as follows: Chief of division (Acting), W. C. Lowdermilk.

Sections

1. Climatic and Physiographic Studies, Dr. C. W. Thornthwaite, head of section.
2. Soil Erosion Control Investigations, Dr. R. V. Allison, head of section.
3. Sedimentation and Hydraulic Investigations, H. M. Eakin, C. E., head of section.
4. Watershed and Hydrologic Studies, C. E. Ramser, C. E., head of section.
5. Economics of Erosion and Erosion Control, Dr. Walter Roth, liaison officer with Bureau of Agricultural Economics, and head of section.

HOLIDAY GREETINGS

To every member of the Soil Conservation Service I extend my sincere wishes for a very Merry Christmas and a Happy New Year.

This is the season when we may well lift our heads a moment from our absorption in maps, contracts, research, and demonstrations, and give a smile and a greeting to a neighbor.

May Christmastide be bounteous in its blessings to you, and may the New Year be fruitful in its realizations.

H H Bennett

EVALUATING EFFECTS OF SOIL TYPE, SLOPE, AND EROSION ON PRODUCTIVITY

By A. H. Paschall and E. H. Reed

The soils and erosion-control practices divisions of the Salt Creek watershed project, Ohio, have devised a system which gives proper weight to soil type, slope, and erosion as factors in crop production.

How the System Works

The system has as its basis the productivity indices of the different soils for various crops as listed in Special Circular No. 44 of the Ohio Agricultural Experiment Station. These index numbers, ranging from 1 to 10, represent the factor of soil in its normal condition on the slope characteristic of that soil. It is possible to introduce the slope and erosion factors and to make compensation for them by applying a percentage differential in the productivity number according to the sum total of the relative effects of slope and erosion on the yields. Field observations have shown that under similar conditions of soil and slope different degrees of erosion show variations in yields. The relation of these variations to degree of erosion represents the effect of the erosion factor. In like manner, the reduction of yields due to slope conditions may be obtained. The total of these percentages for slope and erosion is determined and subtracted from 100. This figure multiplied by the productivity index gives an index number which has been compensated for soil, slope, and erosion factors.

The accompanying table gives this final percentage of reduction as worked out for the sandstone and shale soils in the Salt Creek watershed. In preparing these tables, it was found possible to classify the soils into three general groups: (1) Sandstone and shale, (2) limestone, sandstone, and shale; (3) deep soils. On soils where there are no erosion and slope factors, such as flood plains, 100 percent of the productivity index is used.

"Among other things which have been brought about by the depression is the more honest consideration for the conservation of our natural resources. Especially is the conservation of soils, wild animals, and plants receiving considerable attention."—Montgomery Herald, Troy, N. C.

PERCENTAGE PRODUCTIVITY FOR DIFFERENT SLOPES AND DEGREES OF EROSION ON SANDSTONE AND SHALE SOILS

Erosion classes	Slope classes [1]			
	A	B	BB	C and D
1	105	100	90	70
2	105	100	85	50
27	95	95	80	45
3	80	75	65	30
37	75	70	60	25
38	35	30	25	15
4	55	50	40	15
47	50	45	35	10
48	30	25	20	0

[1] Slope percentage:
A—0–5.
B—5–12.
BB—12–20.
C and D—over 20.
Erosion class:
1—No apparent erosion.
2—0–25 percent surface soil lost.
3—25–75 percent surface soil lost.
4—75 percent plus surface soil lost.
7—Occasional gullies.
8—Severe gullying.

To obtain the index number for the crop land of an entire farm, proceed as follows:

1. Average the productivity index numbers for the crops of each soil type.
2. Derive a corrected index number by the use of the table.
3. Multiply the corrected index number by the total number of acres of each soil type on the farm.
4. Total the products of step 3.
5. Divide this total by the total number of acres. The quotient will be the compensated productivity index number for the crop land on that farm.

This index number represents the production to be expected from the land under prevailing conditions. Should actual yields run higher than productivity indexes, they will constitute a tribute to farm management.

While this method of calculation is imperfect and not to be relied upon for accuracy, it does recognize the reduction in yields effected by erosion and it gives impetus to a study from which much may be expected in the future.

August Jungemann explaining his crop rotation and strip-farming to agricultural field men of a farm real-estate association

VISITORS SEE FARMS RESTORED WHEN EROSION IS CONTROLLED

By I. N. Chapman

Erosion-control demonstrations in the Shue Creek-Wolsey areas, Beadle County, S. Dak., have recently been the object of a number of organized inspection tours.

Two groups of field men of the Federal Land Bank of Omaha, 43 agricultural supervisors of insurance companies, and officials of railroads serving the territory were among those visiting the projects.

The trips were made on days convenient to the interested parties, and included land not under cooperative agreement, as well as land where erosion-preventive methods are in use.

Of Educational Value

These tours proved of great educational value. A statement by W. M. Willy, field man for the Federal Land Bank of Omaha, reflects the deep impression made and is typical of a number of interesting letters received as a result of similar inspection trips. Part of it reads as follows:

That first stop on the Karnstrum 480-acre farm gave one a depressed feeling, to stand in that once beautiful farmyard and see the huge drifts of topsoil piled like banks of driven snow around the excellent farm buildings. The buildings must have cost $15,000, and are now surrounded by hundreds of acres of barren fields.

The slight breeze stirred the silty sand, and blew it into our eyes. On a real windy day you couldn't have faced it. The main road was blockaded by a breast-high drift a half-mile long. The drift completely filled the section line from fence to fence. Uncovered posts here and there were bright with a sand polish from numerous storms. The devastation of this once rich and profitably productive farm land reminded one of a ghastly, deserted battlefield.

Life-destroying forces had been turned loose to annihilate nature's countless centuries of constructive effort, and the pioneering work of two generations of earnest farmers.

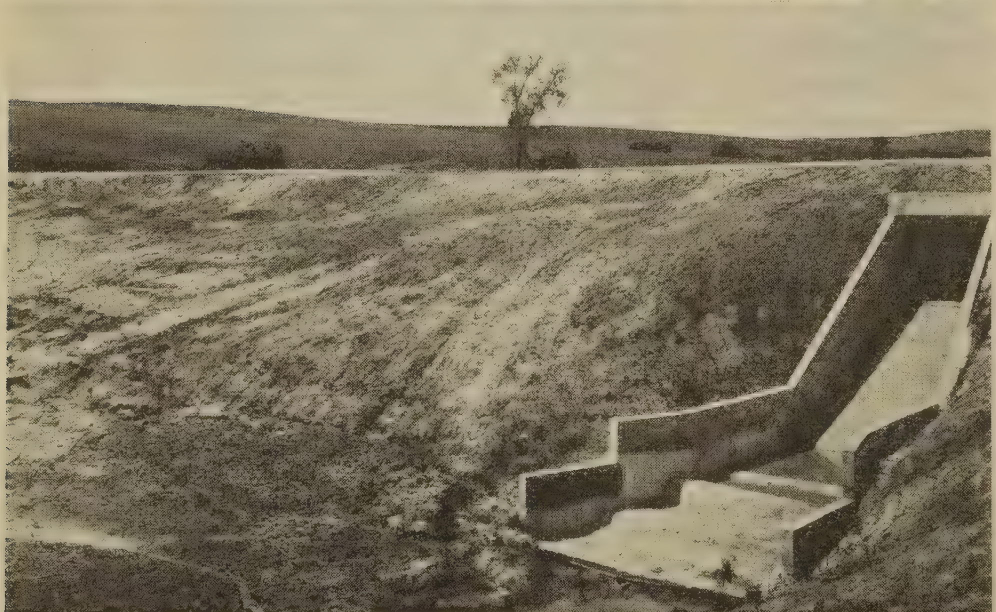
A Picture of Desolation

The picture of warlike wastefulness was made even more vivid when we entered the deserted farmyard of the Giester homestead. Windows were broken, doors blown open, barn roof sagging down, barn walls caving in, fences drifted over, and a splendid flowing well running wild over a yard filled with dust hummocks which were scattered about like banks of earth churned by heavy artillery.

[Continued on page 11]

Taken from center of dam, this picture shows drainage area above and pond formed from melting snow. The water extends nearly 1,000 feet up the gully.

A look into the 22-foot gully, which shows the patch-work job on the bridge pilings. Cooperative effort will be aimed at checking erosion permanently. A large earth fill is included in the plan. Drainage water will be handled by installation of a concrete spillway.



A view of the 6,000-cubic-yard fill and 8-foot box spillway. Trees and grass have been planted on the downstream side of the fill.

HIGHWAY PROTECTION IN NEBRASKA

(Pictures on opposite page)

During the winter of 1934–35, the Soil Conservation Service in Nebraska instituted a program of erosion control in connection with highway structures and the elimination of serious gullying of adjacent farm land.

On one highway in Nance County was a 22-foot gully, spanned by a 42-foot wooden bridge. This was the third structure of its kind that had been constructed over this gully in the last 10 years. Each structure had to be larger and more expensive than its predecessor. Replacement of this particular wooden bridge would have cost the county commissioners of Nance County $2,500. The present bridge was becoming undermined and unsafe, due to undercutting. It called for immediate removal and replacement by a larger and more expensive structure.

Soil Conservation Service engineers undertook a cooperative arrangement whereby the county would furnish the materials, the F. E. R. A. would furnish the labor, and the Soil Conservation Service furnish the technical supervision and design for a permanent structure that would forever eliminate the bridge and at the same time stabilize the erosion on the upstream side of the gully, which was over a mile long. The wooden bridge was removed and an earth fill made, which formed the highway grade.

An 8-foot concrete box culvert was constructed with an inclined spillway on the downstream side. Today the gully, which was formerly impassable has silted almost to capacity. The highway grade remains intact, and the concrete culvert and spillway has been successful.

Approximately 25 similar structures have been built in the Plum Creek drainage area. The technical layout was supervised by engineers of the Service. Actual construction has, in most cases, been done by F. E. R. A. labor and, in many cases, private landowners have put up the money, or a portion of it, for the materials needed

A recent understanding has been entered into with the commissioners of Boone and Nance Counties, under which technical assistance will be furnished by the Service in the design of all bridges and culverts on highways in the Plum Creek drainage area. Further agreements have been entered into with the county commissioners which will permit the Service to use W. P. A. labor as far as authorized in connection with the construction of these bridges and culverts when weather conditions do not permit erosion control operations in the field.

This is a field of cooperation which offers a practical solution toward the conservation of agricultural lands and the elimination of an enormous expenditure of public funds.

VISITORS SEE FARMS

(Continued from page 9)

The family had been driven away by the many attacks of drifting soil. Their neighbors had been separated and scattered to the ends of the earth—14 families in the immediate community were forced to desert their comfortable homes because of this awful warfare of the savage and relentless wind.

One could not help asking, "Isn't there some way to stop this deadly destruction of soil and humanity?"

But the Jungemann place was a revelation to me! The last time I had paid careful attention to this farm was in the early spring of this year.

It was on a windy day. I stood between the Jungemann house and the barn. I could scarcely see either. The clouds of swirling dust enveloped me like a raging black blizzard. It pained the lungs to breathe. The surrounding fields were a veritable desert. All it needed to make the comparison more realistic was a few camels standing in the lee of a dust bank—and it required very little imagination to see them.

On the day of our project visit all that was changed. The drifted dirt had been removed from around the buildings, from the fences, from the trees, and from the highway. The horse-high hummocks in the fields were leveled down. Alternating rows of corn and small grain, planted in diagonal strips at right angles to the prevailing winds, had taken complete possession of the fields. A healthy growth of sweet clover was already at work restoring the wasted vital elements of the topsoil.

The neat appearance of the farmyard gave ample evidence that the good, thrifty German farmer who lives here had again taken heart. He had been encouraged to stick it out. He was continuing his fight to maintain his family and to save his home—a home which he himself had wrested from the wilderness nearly 50 years ago.

The forces of engineering, of agronomy, of forestry, of farm management, of education, and of inspiration which you have marshalled on the Jungemann farm point the way to rehabilitation of drifting wind-blown areas. The results already accomplished here by the Soil Conservation Service conclusively prove that wind-damaged areas can be controlled, and better yet, restored to usefulness under their present owners.

MACHINERY THAT FACILITATES THE HARVESTING OF GRASS SEED

By Guy C. Fuller

One of the problems connected with the reestablishment of native sod in dust-blown regions concerns itself with the harvesting of seed.

Grass nurseries have been set up by the Soil Conservation Service, therefore, to collect native grass seed for the reseeding of large areas of abandoned land; to encourage reseeding and improvement of those areas that are approaching abandonment; to increase and encourage the use of valuable species never before introduced; to discover the best cultural methods and encourage proper management of vegetation.

At the moment we are focussing attention on the lands west of the ninety-eighth meridian—a significant line of demarcation because it is here that grasses divide into groups, with the tall ones to the east and the short ones to the west.

Conferred on Program

Last May a number of regional nurserymen, agronomists, and State cooperators attended a meeting in Colorado Springs to formulate a program for the work west of the ninety-eighth meridian.

They gave attention to the factors involved in establishing meadows with one or all of our native grasses. Extreme care is required in harvesting the seed, in application of methods of seeding, in date and rate of seedings and in seed mixtures.

In general, the harvesting of this native seed can be done with the present machinery. The wheat grasses and many other tall grasses can be harvested with ordinary farm machinery, but some of our short grasses present a more difficult problem.

Many species occur in waste places along railroad banks, roadsides, fence corners, and rugged hilltops, making the use of harvesting machinery impracticable. Seed collecting in such places is done by hand. The tops are cut with sickles or large knives and put into bags thrown over the shoulder. These tops are dried and later threshed and cleaned.

Hand Stripper Developed

Seed gathering in such places has been greatly facilitated by a hand stripper devised by Gerald Mott, a Government employee at Stillwater, Okla. This device derives its power from a two-cylinder washing-machine engine. The dimensions of the cylinder are 40 inches by 14 inches. It operates at 700 revolutions per minute. The hopper is of sheet metal mounted on an eccentric frame supported by two automobile wheels on pneumatic tires. The eccentric frame allows for height adjustment. The use of such a machine is limited but it serves the purpose for which it was designed.

One of the most economically valuable grasses is Blue grama (*Bouteloua gracilis*) which is widely adapted to the Great Plains area and is recognized as one of the most valuable species for erosion control. This being a short grass, the use of the combine is not possible, and to mow, rake, or thresh the crop would not be feasible because too much seed would be lost in handling; therefore, grass strippers were used for harvesting this crop, and they worked satisfactorily wherever large machines could be operated.

A Horse-Drawn Type

A horse-drawn stripper—another recent development—will cover from 6 to 7 acres a day, requiring one man and a team to operate. The cylinder in this case is a hollow drum made of wooden slats filled with staggered rows of spikes. The speed of this cylinder is also about 700 revolutions per minute. Height adjustment ranges from 6 inches to 14 inches.

Short cuts and labor-saving devices are always worth considering, on any job, so to speed up the work with these machines the long tongue used with a team was replaced with a short one and three machines were hooked in tandem and pulled with a tractor. Thus arranged, the strippers will cover from 25 to 30 acres a day, one additional man being required.

In this way costs are reduced and a larger acreage is covered in a given time. The importance of this may be emphasized by the fact that under certain conditions ripe seed is shattered within a few days.

Such machines as these are very limited in usefulness because of the height adjustment. The ideal stripper for harvesting native grasses is economical, able to cover from 25 to 40 acres per day, is adjustable to grasses ranging from 6 inches to 4 inches in height and is simple to operate.

A power stripper, the first machine of its kind, was built at Oshkosh, Nebr., and, although not perfect, it approaches our objective.

Following is a comparison of this stripper with a horse-drawn stripper:

Tractor-drawn:	Horse-drawn:
10-foot swath.	6-foot swath.
4-foot range in height.	18-inch range in height.
25 to 35 acres per day.	6 to 7 acres per day.
Transported under own power.	Truck.
One man.	One man.
Gas and oil.	Team.

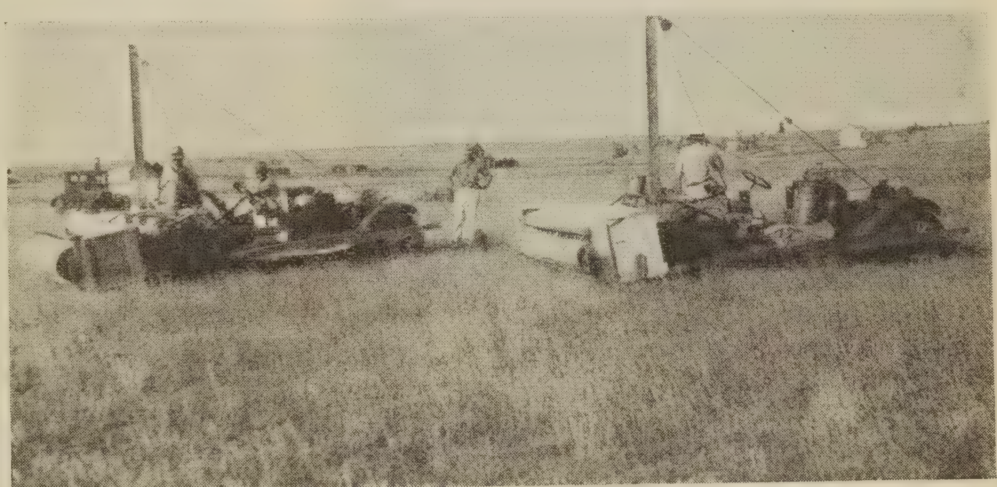
An old automobile chassis serves as the power unit. The rear axle is thrown over, producing a pull instead of a push effect. The steering gear is attached to the frame over the rear axle with the steering rods lengthened. A cylinder is mounted in one side of the large hopper, just as in the horse-drawn stripper. A bar 10 feet long with 18 inches on each end turned at right angles and fastened near the end of the frame forms a support for the hopper. A steel cable with adjustable clamps extends downward and fastens to the back side of the hopper. A long lever attached in the center produces a lift or height adjustment by eccentric action.

The cylinder is driven from what is now the front wheel by chains and sprocket wheels. The size of the sprockets determines the speed of the cylinder.

Advantages in favor of the power stripper are:

1. It moves under its own power.
2. It may be transported from one field to another without any adjustment.
3. The height adjustment ranges from 6 inches to 4 feet.
4. It is possible to secure cleaner seed because of the flexibility of the cylinder and hopper. By pulling down on the rope the hopper is raised, allowing it to pass over noxious weeds or any other undesirable materials.
5. This adjustment allows the machine to be operated upon rougher ground and much of our native seed is harvested in fields where machinery has never been used before.
6. It can be operated by one man.

These strippers and our ordinary farm machinery have solved satisfactorily the problem of harvesting most grasses, but leave us another harvesting problem of greater magnitude, which will be discussed in a later article.



Two of the newly developed power strippers in operation in the west.

A GOOD COVER GRASS

Bermuda grass, says Charlie Acres, who lives near Greenbrier, Ark., helps to control erosion and supplies good grazing on the rolling slopes of his farm. He has used it for pasture a number of years and finds that cattle, mules, and even pigs are fond of it, that even a small area, well sodded, is an asset to a farmer in his section of the country.

On his creek-bottom farm, he has produced Bermuda for hay, having succeeded some seasons in mowing and saving it when it has not been too closely grazed.

He has noticed that heavy rains the past spring have been disastrous to steep slopes of cultivated fields on farms where there are no vegetative covers and where terraces have not afforded a means of holding run-off till it can percolate. In his own fields, where slopes have been taken for Bermuda grass cover, over-sown to lespedeza, after they have been contour furrowed, erosion has been controlled. For sodding slopes Bermuda has no equal in erosion practice, he believes.

HEAD EROSION AT ITS WORST

A 6-day debacle of an irrigation diversion canal in the Gardena farming district in Washington produced a gully 1,500 feet long, 30 to 120 feet deep, 75 to 120 feet wide—an excavation of approximately 325,000 tons of soil!

The story of this Burlingame irrigation tragedy is as fantastic as it is true.

Built in 1904, the diversion canal 2 miles south of Lowden, Wash., and 14 miles west of Walla Walla,

Overshot flume with which it was hoped to stop head erosion.

served to control the stream flow of the Burlingame irrigation ditch. When the March winds blow each year, tumble weeds whipping along the canal are stopped and piled up by the concrete constriction of the channel at the intake, choking the flow of water. To clean out these accumulated obstructions, the stream flow was temporarily shunted into another diversion canal emptying into Pine Creek a few miles distant.

Started on Small Scale

Until March 1926 a small gully about 10 feet deep and 6 or 8 feet wide was all that marked what was to become a miniature Grand Canyon.

It was then, however, that the winds blew steadily for 6 days and the entire 80-cubic-feet-per-second flow of the main canal, which irrigates 5,000 acres of fertile land, was crowded into the diversion ditch. Under this extraordinary pressure, the stratum of hard underlying material gradually gave way and head erosion began in earnest.

The gully became a gulch: The gulch became a canyon. Below the hard stratum lay an old lake bed deposition of sand and soft, fine clay which allowed the miniature falls to cut deeper and deeper and offered little resistance to the forces of head erosion. In 6 days the gully grew, carrying hourly more than 2,000 tons of soil and removing approximately 4,725,000 cubic feet of earth. The water flowing into Pine Creek was estimated to contain more than 18 percent silt by weight. Thousands of tons of silt were carried into the Columbia by the creek.

Failure of Flumes

The following year, 1927, an overshot flume was built and projected into the mouth of the canyon to prevent further heading. But the combined action of the water, freezing and thawing, loosened the footings and caused the structure to fall to the chasm bottom. Another flume was built, but this, too, will fall if steps are not soon taken to insure its retention.

Due to weather action, the walls of the gully slough off an annual deposit of loose soil which collects from 8 to 10 feet deep in the gully bottom. Each March, when the wind blows, the water is again turned into the chasm and the loose material melts like sugar in a few hours and the sirupy silt rolls on to the Columbia.

At the present time this overgrown gully has widened to an average of nearly 100 feet at the top and has a maximum depth of 120 feet. A recent survey by engineers of the Soil Conservation Service project at Athena, Oreg., found that more than 9,588,000 cubic feet of earth have been removed. It has cut back into a long, sloping ridge standing as an erosion remnant of a once higher land.

Geological Explanation

Prof. B. H. Brown, of Whitman College in Walla Walla, who has made an intensive study of the geologic history of this gorge, reasons that the alternate hori-

A general view of the spectacular gully caused by the overflowing of the Burlingame irrigation ditch.

zontal strata of sand and clay indicate the remains of old lake bed deposition. These sand strata vary from 6 to 14 inches in thickness. Each set of strata, composed of one layer each of clay and sand, represents a flood period. Whether they were annual floods, or caused by rains, melting snow, or ice cannot be determined.

There are many vertical seams of sand and clay as much as a foot wide, which extend from the bottom of the gully upward and terminate at various elevations, but always at the upper surface of a clay stratum.

"These seams", says Professor Brown, "were once large cracks which occurred during the time when the lake became dry." At intervals during a dry period small floods of short duration spread over the lake bed and washed the sand and clay down into these cracks.

Remnants of Granite

Although all rock in this region is of basaltic origin, pieces of granite of various sizes appear at different levels in the clay strata of the gully. These remnants of granite were evidently brought down from the north by glacial ice. As the ice broke up and floated out on this lake and melted, the rocks were precipitated to what was at that time the lake bottom, where they now lie at various depths. Due to the granite which is found at different levels and because the lake appears to have been completely dry at intervals, Professor Brown is led to believe that the forming of these stratifications and the glacial age were coexistent and that the glacial ice came down at several different periods.

Parts of mastodons and other prehistoric animals, including a tooth weighing three and one-half pounds, have been found in the gully. The presence of these historic relics gives the thought that some time had elapsed since this lake was in existence.

Our project engineers have suggested a plan which will control erosion in the gulch. The plan, in brief, calls for the construction of a wooden flume around the gully which will detour the water from the diversion canal to Pine Creek around the present washout. Then the walls of the gully would be broken down and the gully allowed to stabilize itself with vegetation.

Threatens Farmhouse

Large earth cracks are now visible along the rim. Because of the danger involved, Professor Brown has discontinued the practice of taking his geology students to the gully. If not soon controlled, the gully will eventually engulf a farmhouse which lies in the course of its erosion.

A spectacular example of head erosion at its worst, the Burlingame irrigation monstrosity is a destroyer of land, a menace to lives and property, and a source of future expense to the Bonneville Reservoir.

"Soil-erosion control is one step in a program that should be earnestly encouraged throughout the South. It should be accompanied by crop rotation—in fact, it is the big brother of that scheme of diversification which seeks to keep land active, productive, and remunerative."—Tyler (Tex.) Courier-Times.

CHECK DAMS STABILIZE GULLIES

Planting willow cuttings in a gully. With the brush and wire check dams holding active erosion in check until the trees become well established, permanent control is expected.

In the Plum Creek drainage area, Boone and Nance Counties, Nebr., the Soil Conservation Service, using E. C. W. labor, has completed the construction of several thousand temporary brush and wire check dams such as the series shown here.

Above each dam there is a silt deposit of approximately 4 feet in depth, as shown in the picture. This type of structure has stabilized active erosion in the bottom of the gully. C. C. C. boys are engaged in planting willow cuttings in the accumulated silt to establish permanent control.

In a few years many of the deeper gullies will be partially silted in, and erosion permanently stabilized by trees, shrubs, grass, and other vegetation.

Farmers in this area like the idea of producing in these gullies something that will be of economic value. The trees will furnish a source of wood and posts, and afford a protection to wildlife and game, as well as change an unsightly and destructive gully into a timbered spot of beauty and usefulness.

RELIEF LABOR

Exceeding its quota by more than one-third, November 16 reports from all parts of the country indicate gratifying progress in the employment of relief labor by the Soil Conservation Service.

A statistical summary as of this date follows:

Rank	State	Number relief workers	Relief labor quota	Acting State coordinator	Percent of relief labor quota
1	Idaho	222	54	Rockie	411.1
2	New York	982	365	Howe	269.0
3	New Jersey	605	236	Lee	256.4
4	South Carolina	1,380	637	Carnes	216.6
5	West Virginia	356	173	Cutler	205.8
6	Michigan	316	156	Cutler	202.6
7	Ohio	797	402	Cutler	198.3
8	Colorado	1,245	632	McClymonds	197.0
9	Missouri	803	437	Uhland	183.8
10	Virginia	552	310	Carrier	178.1
11	Maryland	277	156	Bruce	177.6
12	Minnesota	311	178	Davis	174.7
13	Iowa	610	486	Uhland	125.5
14	Georgia	1,101	655	Rast	168.1
15	Oklahoma	1,260	800	Winters	157.5
16	South Dakota	545	349	Cleamer	156.2
17	*Nursery*	674	253	Enlow	266.4
18	Kansas	604	390	Doley	154.9
19	California	959	629	Reddick	152.5
20	Indiana	232	156	Cutler	148.7
21	Nebraska	252	172	von Trebra	146.5
22	Wisconsin	293	205	Davis	142.9
23	Illinois	417	294	Fisher	141.8
24	Pennsylvania	598	435	Patrick	137.5
25	North Carolina	1,486	1,110	Stallings	133.9
26	Washington	157	118	Rockie	133.1
27	Texas	1,743	1,342	Merrill	129.9
28	Mississippi	780	620	Anders	125.8
29	Arizona	1,941	1,556	Boyle	124.7
30	New Mexico	1,942	1,569	Calkins	123.8
31	Arkansas	838	730	Sargent	114.8
32	Kentucky	282	257	Alberts	109.7
33	Oregon	176	185	Rockie	95.1
34	Alabama	365	390	Bailey	93.6
35	North Dakota	123	156	Clemmer	78.8
36	Louisiana	470	550	Mims	85.5
37	Wyoming	140	311	McClymonds	45.0
38	Montana	70	156	Aicher	44.9
39	*Research*	489	1,354	Allison, etc	36.1
40	Utah	27	136	Calkins	19.9
41	Florida	13	91	Bailey	14.3
42	Maine	0	97	Patrick	0
43	Nevada	0	156	Reddick	0
	Total	26,433	49,444	Average	135.9

BURNING CAUSES LOSSES

Burning meadow land is an expensive operation, says C. B. Watkins, Logan County (Okla.) farmer.

An accidental fire burned 45 acres of prairie meadow land on Watkins' farm on August 10, 1934. In 1935, a fair year for hay production, the yield on the meadow was less than half normal and weeds in the hay caused it to be unsalable.

Experiments conducted at the Red Plains Soil Erosion Experiment Station, Guthrie, Okla., prove that Watkins' experience is not at all uncommon. Five-year experiments show that burning multiplies the water loss by 28 and the soil loss by 12.

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SOIL CONSERVATION

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JANUAR
1936

Mr. Fechner Writes of the Work of the Civilian Conservation Corps in the Control of Soil Erosion

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WELLINGTON BRINK — EDITOR

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HENRY A. WALLACE
Secretary of Agriculture

H. H. BENNETT
Chief, Soil Conservation Service

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ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON

THE C. C. C. IN SOIL CONSERVATION

By Robert Fechner

Director Emergency Conservation Work

Mr. Fechner.

Two hundred years have elapsed since Jethro Tull, then an obscure British agriculturist, wrote his famous "Essay on the Principles of Tillage and Vegetation" to start a new trend in land use. The first President of the United States, on his death bed, had foresight to pen final instructions for prevention of soil losses on his three farms.

But the present mode of curbing soil erosion is decidedly new. It was not until establishment of the Civilian Conservation Corps and the Soil Conservation Service in 1933 that a vigorous step was taken in this direction.

At that time the Civilian Conservation Corps was an experiment. It was but natural that many communities should look a bit askance at these sprawling tar-paper buildings which began to dot the country. Many communities expressed doubts as to the advisability of having 200 young C. C. C. men established in the vicinity. In some quarters the question was raised as to the actual value of the type of work which the C. C. C. had been organized to perform.

It took only a few months, however, to convince the Nation that the C. C. C. was a worth-while organization. As the success of the first few camps became generally known, demands for the approval of new C. C. C. projects began to come in huge numbers to the Office of Emergency Conservation Work. For 2½ years there has never been a time when we could begin to supply the demand on the part of communities for C. C. C. camps.

During the past 18 months, a million and a half young men have left the ranks of the unemployed to

A noonday halt. These C. C. C. boys, in Ohio, planted many thousands of trees used for erosion control. Approximately 250,000 pounds of black walnut, hickory, and oak were seed-spotted during the past season east of the Mississippi River.

38080—36

enter the Civilian Conservation Corps and engage in conservation work. At first these camps were assigned largely to forest and park-improvement projects. Since then the scope of the work has been broadened to include large-scale soil-conservation work, reclamation, grazing, and mosquito-control projects, wildlife-conservation activities, flood-control and drainage projects. In all these fields substantial conservation work has been completed. Our greatest accomplishments have been in the improvement of forest stands, the development of protective facilities in our forests and parks, the improvement of timbered areas for recreational use, and the prevention of soil erosion.

Early Camps

The C. C. C. and the Soil Conservation Service joined hands in April 1934, when 22 camps were allocated to what was then known as the Soil Erosion Service. These camps, located on 14 demonstration areas in regions where soil erosion presented a critical problem, and where there was an urgent need for the type of labor these camps could supply, were augmented by 12 of the 172 new 200-man camps established during the drought-relief period.

Popular approval given to the work accomplished by these camps assured their continuance and the assignment of 17 additional camps to the battle against soil erosion. Today, 501 of the 2,500 C. C. C. camps are being operated under the technical supervision of the Soil Conservation Service. The number of C. C. C. enrollees actually at work in the soil-erosion camps has more than doubled in the past 3 months.

Soil-erosion control work has come to be greatly appreciated in farming areas, and projects completed are already serving as valuable demonstration areas to farmers and landowners. Some idea of the work that had been completed through July 31, this year, is shown in a recent report compiled by the Bureau of the Census from figures forwarded to Washington from the various erosion-control camps. These records disclose that 1,315,255 temporary check dams have been completed in the course of carrying out the gully-control program. Other gully-control work included the planting of trees over 45,000,000 square yards of eroded lands, the seeding or sodding of 3,700,000 square yards of eroded land, the digging of 4,068,000 linear feet of ditches, and the sloping of 129,372,000 square yards of banks. About 2,000,000 acres of land have been covered in the gully-control work.

While Civilian Conservation Corps workers do not make a practice of actually constructing terraces in connection with the soil-erosion prevention program, they construct the necessary outlets. Since the program began more than 36,000 temporary and permanent terrace outlet structures have been constructed by the C. C. C. boys. More than 1,000,000 linear feet of outlet channels have been completed to date. The planting of trees and other vegetation for the purpose of preventing soil wastage has been one of the important erosion control activities.

It is estimated that more than 50,000,000 trees have been planted in connection with the soil erosion prevention program.

Just what will this expanded program mean to the Federal campaign for soil conservation? It will mean that soil conservation will be advanced far beyond the fondest hopes of a year ago. It will mean that the program will be extended to many regions where erosion is a critical problem, which could not be included in initial plans.

The work of the soil erosion C. C. C. camps has been largely restricted to gully control. Plans for the future have been broadened to include almost every type of approved erosion control—and it should be borne in mind that, while these camps are operating on private land, the purpose is not primarily to benefit the owner of the land but to demonstrate to every landowner in the region just how he may help himself.

What Is Ahead

The 501 camps under the Soil Conservation Service expect to treat in the next 12 months, more than 6,000,000 acres of farm lands now suffering soil losses from water or wind erosion or both.

In this expanded area, they plan to build more than five times as many check dams and other gully-control structures as were built during the last 12 months. A total of 348,808 dams were constructed during the past year. Plans include the construction of more than 1,800,000 check dams in the 39 States in which the camps will operate. These gully-control structures are to be supplemented by more than 1,500,000,000 square yards of seeding and sodding, and 120,000 square yards of bank sloping.

Reforestation of denuded slopes, lands too steep for safe cultivation, will also be a major activity. Preliminary surveys of the Soil Conservation Service estimate that more than 425,000,000 trees will be planted, com-

"Before and after"—Above, a bulldozer poised at the edge of a 46-foot-deep gully on a farm near Tigerville S. C., as it begins sloping the right bank. Below, the task nearing completion

C. C. C. men building a log check dam in Illinois.

pared with 30,446,500 trees planted on denuded slopes and in gullies during the preceding year.

Comparative figures such as these could be continued, to show the proposed work in terrace-outlet and outlet-channel construction, in diversion ditches and dikes, in rock quarrying, in seed collection, and nursery planting—but the few figures already given should afford a good idea as to just what the expanded C. C. C. program will mean to soil conservation.

There is another side to the program which deserves mention. As the new C. C. C. camps have been set up, enrollees of proved ability have not been forgotten. Where possible, foremen for the new camps have been recruited from the ranks.

Equipped by Experience

Not long ago, an ex-C. C. C. enrollee applied for a job to a construction foreman. The foreman pointed to a huge gully.

"Can you build a bridge across that gully?" he asked.

"Sure", was the calm reply. That has been exactly the kind of work this enrollee had been doing in a soil-erosion camp. He built the bridge, and was placed in charge of a crew. He had learned his stonework from building check dams in his former camp.

The Civilian Conservation Corps owes its popularity to the fact that it is doing worth-while work in the fields of youth rehabilitation and conservation. The thousands of letters received from States and local communities testify to the value which the country places on the C. C. C. work. One need only look at the bronzed lads working in the fields to see what the movement has done for them.

I am convinced that this work should go on. It is a type of work that has been generally beneficial to the entire community and in the development of our forest and park areas for recreational enjoyment we will be offering all of our citizens opportunities that only a few of them have hitherto enjoyed. Through the development and improvement of our forested areas we will preserve for future generations one of our most important natural resources. By continuing the work in soil conservation we can make an important contribution toward assuring future generations an adequate food supply.

Because a real service is being performed that not only is helpful to those directly engaged in it but offers opportunities not previously available to millions of our citizens, I am firmly convinced that the C. C. C. has fully justified the faith reposed in it and that it is returning a value in full proportion to its financial cost.

Poor land breeds shiftlessness and we shall spread rural slums throughout the Nation unless we do something to save it from degeneration. It is not necessary to have any illusions about changing human nature to feel that the rural poor must be helped. In the national interest we ought to give such of them as we can a chance to better themselves and to raise their families by decent standards of citizenship.

This is the direction in which conservation must now be turned. . . . To save the land and the people who depend on it is an aspiration in which all of us, it seems to me, can join.—From an address by Rexford G. Tugwell, Undersecretary of Agriculture, before the 50th Anniversary of the Founding of New York's Forest Preserve.

When we learn to use submarginal land for the purpose to which it is best suited, the true value of the area will be revealed, and such territory will take its rightful and worthy place in the world of agriculture.—Western Farm Life.

MEETING THE MENACE OF OVERFLOW WATERS

By Henry M. Eakin

Specialist in Sedimentation Studies

Comprehensive flood control includes not only the simple confinement and guidance of waters but control of erosion and the transportation and redistribution of sediment as well. Under such a composite practice the aims of river improvement can well look to an economic extension of flood control over the Nation as a whole, more real and permanent security of lands already temporarily benefited, and the gradual recovery and improvement of lands now condemned to damaging overflow.

The average annual direct flood damage within the United States outside the Mississippi Valley has been appraised at about $35,000,000. For the Mississippi Valley the future of flood damage is problematic, owing to the extensive improvement works now under way. In addition to direct property damage, account should also be taken of impairment of values, due to flood menace and deferred development of large areas of potentially high-value lands.

Influence of Upland Erosion

Erosional denudation of uplands decreases percolation of water into the ground and materially increases the volume of run-off from rainfall. Gullies extend open channels and abnormally steep headward slopes toward divides and induce abnormally rapid inflow of water from periphery to center of watersheds. This tends to give abnormally high and steep fronted flood waves and new orders of flood discharge.

Upland erosion also produces abnormal volumes of erosional waste which trunk streams are compelled to handle and distribute. Streams thus overloaded tend to shoal their channels and flood their valleys to progressively higher levels under given discharge. Man-induced erosion thus tends to increase flood heights by increasing flood discharges and decreasing discharge capacities of streams. Control of upland erosion offers large and essential results toward basic, permanent flood control.

Headwater Reservoirs

Flood discharges can be reduced in favorable cases by temporary storage of flood peaks in headwater reservoirs and valley-detention basins. These measures are admirably adapted to many small river projects. However, their possible proportionate reduction of flood discharges decreases as the size of the affected river becomes larger. For very large river systems their effects are relatively small and costs high. Such reservoirs and basins tend to fill up with sediment and lose capacity, particularly in regions of accelerated and uncontrolled erosion.

Levees

Levees are direct means of raising flood levels in order to restrict their lateral spread. A measure of protection of portions of the valley lands is thus directly afforded.

Levees in large river valleys have little effect on the rate of total sedimentation. They do, however, restrict deposition to the relatively narrow zone between the levees. This gives a higher rate of increase in depth of deposits and a smaller cavity than the whole valley to be encroached upon by sediment accumulation. As flood levels rise levee grades must be correspondingly elevated to maintain a safe margin of levee freeboard. Such elevation is toward a practical limit set by backwater encroachment upon lands sought to be protected and foundation conditions of the levees themselves. In long alluvial valleys sedimentation eventually raises flood levels higher than it is practicable to maintain a levee system. This fact was the eventual doom of the old "levees only" theory and practice on the Mississippi.

Revetment or Bank Protection

The protection of caving banks by revetment prevents normal replenishment of stream load with fine-grained materials to compensate bar deposition. Subnormal volumes of load are induced in lower reaches of the river and the rate of total valley sedimentation is increased. At the same time the channel is denied normal addition of new cavity area to compensate encroachments of growing bars. The effects of revetment on flowage conditions tend to increase the height of floods. General revetment of a large alluvial river receiving coarse-grained erosional waste from tributaries can be attempted only at disastrous expense and critical aggravation of floods.

For the directly intended purpose of protecting lands from caving into the river revetments are effective, but justified only where property values are exceptionally high or where local features of river alinement are essential to equally important engineering purposes.

Floodways

The practice of diverting portions of flood discharges through auxiliary floodways past regions of deficient main-channel capacity directly effects a lowering of flood stage. While in action such outlets increase sedimentation downstream from the point of egress of water from the main stream. Where outflowing waters lose velocity due to spreading and backwater effects, sedimentation is again favored.

The deposits in both of these situations tend to restore initial flood elevations.

The general rate of valley sedimentation and progressive flood elevation between the levees is but little affected.

In general, valley floodways are extremely expensive in lands—usually the best quality lands of the valley were they not condemned to periodic overflow. Where large discharges are diverted over essentially flat terraine the practice becomes in reality one of selective flooding rather than true floodway protection of lands.

Channel Contraction

The practice of channel contraction makes use of both solid and permeable dikes, wing dams, retards, training walls, and other structures and seeks to induce a deepening of the stream channel at the expense of its width. The purpose of these is improved navigability with minimum harm to flood control. In their readjustment to contraction works, stream channels lose cross-section area through induced accretion to bar and bed deposits and gain area in the region of the low-water channel. The process of gain in cross-section area lags behind that of loss with respect to time and is less in ultimate amount. The net effect of channel contraction, therefore, is quite generally a reduction of flood-discharge capacity and higher floods.

Cut-offs

The direct hydraulic effect of cut-off of a river bend is to reduce flood levels upstream and increase them somewhat in succeeding downstream reaches. Erosional readjustments following cut-offs tend to distribute these changes of flood elevation more widely up and down stream. Sedimentation is effected through increase in delivery of coarse-grained materials downstream. A number of cut-offs at the same time tend to combine in erosional effect and lead to material shoaling and widening of the channel in downstream reaches. Where levees are already raised to their practical limit these changes in channel form and flood elevations below cut-offs may be critical.

In nature the sedimentary effects of cut-offs are compensated by increased bank caving and resortment of debris which tend to maintain channel capacity at lower elevations. Where revetment of banks is practiced along with artificial cut-off of river bends, adverse channel readjustments and higher flood levels are doubly invited.

VOLUNTARY ASSOCIATIONS

Up to December 15, 22 memoranda of understanding between the various State extension services and the Soil Conservation Service had been approved. Additional memoranda were pending.

Articles of association for voluntary groups received in Washington as of December 15 follow:

Alabama, 11; Arkansas, 33; Idaho, 1; Illinois, 18; Louisiana, 21; Mississippi, 10; New Jersey, 3; New Mexico, 1; New York, 3; North Carolina, 10; Oklahoma, 29; South Carolina, 14; Tennessee, 5; Texas, 38; Utah, 1; Virginia, 9; Washington, 5; Wisconsin, 8.

Pioneering in organization of this type of association even prior to issuance of the report of the Secretary's Committee on Soil Conservation were W. A. Rockie, regional conservator, and A. L. Hafenrichter, regional nurseryman, Pullman, Wash. They filed articles, subsequently revised in accordance with the report, under which five associations got off to an early start in this important phase of the soil conservation program.

With 501 E. C. W. camps engaged in soil conservation work in 39 States, it is probable that a number of additional voluntary associations had been formed for which articles of association had not been received.

State advisory committees had been organized in the 48 States. In most States they had held one or more sessions and the State programs were reported well under way.

SEED COLLECTED IN LARGE QUANTITIES

Approximately 3,000,000 pounds of tree and shrub seed, in addition to 1,000,000 pounds of grass seed, have been collected by the nursery section of the Soil Conservation Service.

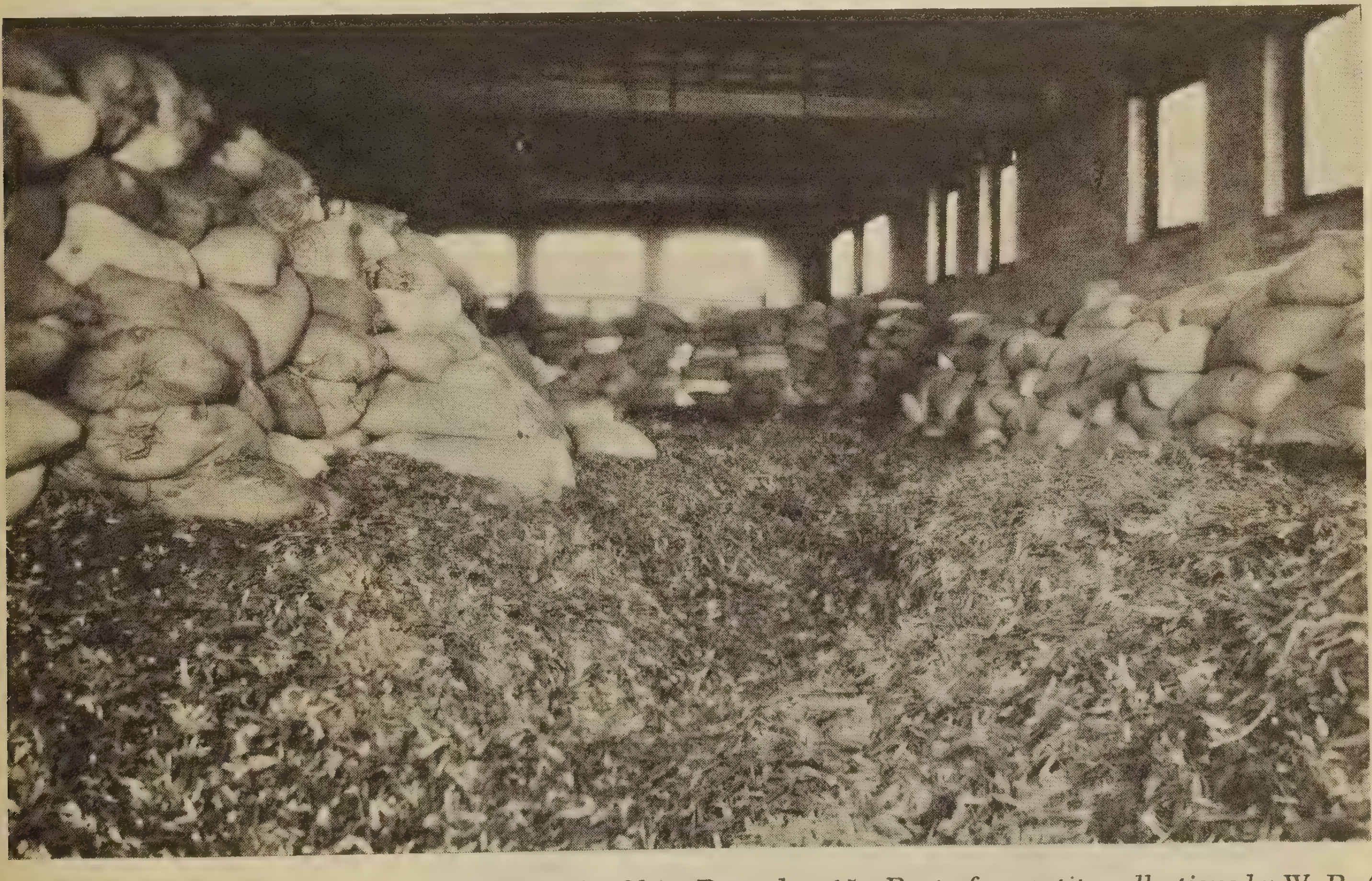
The grass seed, together with quantities of acorns, walnuts, and hickory nuts, will be planted on demonstration projects. Most of the tree seed is, however, for nursery planting. Collection of the latter was largely accomplished by relief labor and enrollees of the Civilian Conservation Corps.

Far West Did Well

Although Ohio, Pennsylvania, and other areas contributed to the success of black-locust-seed collection special honors in this important phase of the program go to Dr. A. L. Hafenrichter, regional nurseryman, and W. A. Rockie, regional conservator, and his staff at Pullman, Wash. Virtually no quantity collections of locust seed had previously been made in the intermountain region, but on November 29 the prospect was favorable to obtaining the entire 100,000 pounds of clean seed requested of the area.

Jack pine cones collected by W. P. A. labor in Crawford County, Mich.

Notwithstanding the fact that the black locust is native in the United States, most of the seed of this tree used by the Service in the past 2 years was purchased from Europe. Such importations always carry the risk of bringing some new pest into the country and are, therefore, frowned upon by pathologists and entomologists. By collecting the seed in this country, many thousands of dollars have been kept at home, the disease danger has been minimized, and a new local industry, collecting locust seed, has been developed in Idaho, eastern Oregon, and Washington.



Black locust seed in a warehouse at Zanesville, Ohio, December 15. Part of quantity collections by W. P. A. and C. C. C. labor.

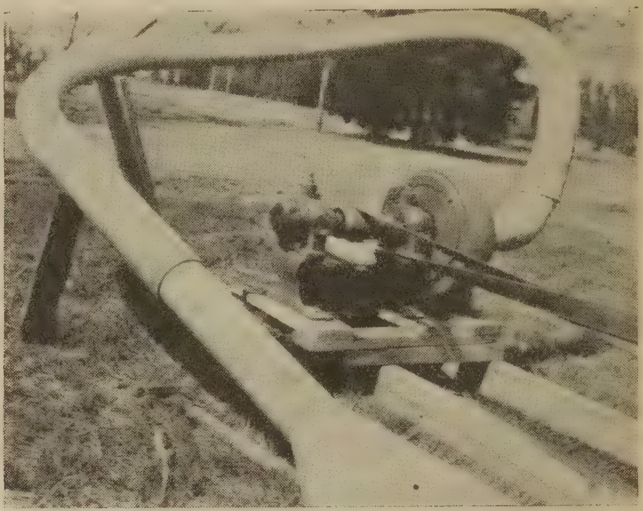
DEVELOPING MACHINERY FOR HARVESTING BUFFALO GRASS SEED

By Guy C. Fuller

(The second of two articles on the development of machinery for the harvesting of grass seed)

The story of how thousands of acres of valuable native grass sod were turned under with the plow to grow $2 wheat, and later abandoned, is a tragic part of our agricultural history. Drought and dust storms have brought home to Great Plains farmers the need of reestablishing a covering upon this vast acreage that will successfully resist the onslaught of sun and wind.

At the Colorado Springs conference referred to in a previous article, each project manager was requested to estimate the quantities of native grass seed that he could use profitably in his area. Buffalo grass (*Buchloe. dactyloides*) led the list with 105 tons. The size of this total indicates the importance of the grass.



First assembly of vacuum machine designed for harvesting buffalo grass seed. Operated by gasoline engine and transported on trailer.

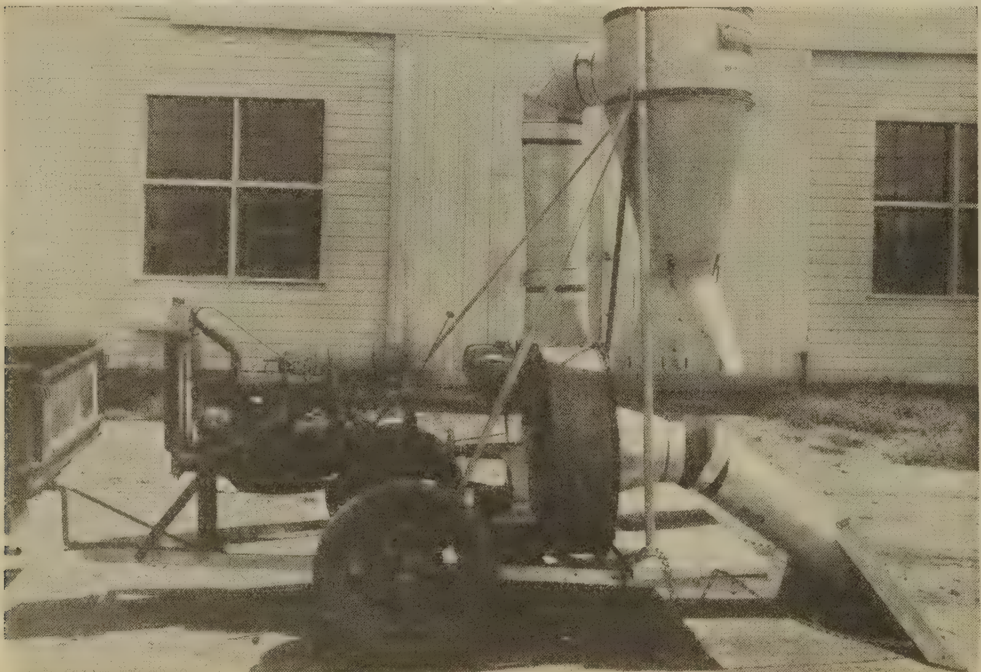
Drought Resistant

Buffalo grass has demonstrated its drought resistance and its ability to stage a comeback with the return of favorable conditions.

It is palatable and highly nutritious at all stages of growth. It is widely adapted to soils and climatic conditions, and may be propagated by seed or vegatatively with pieces of sod.

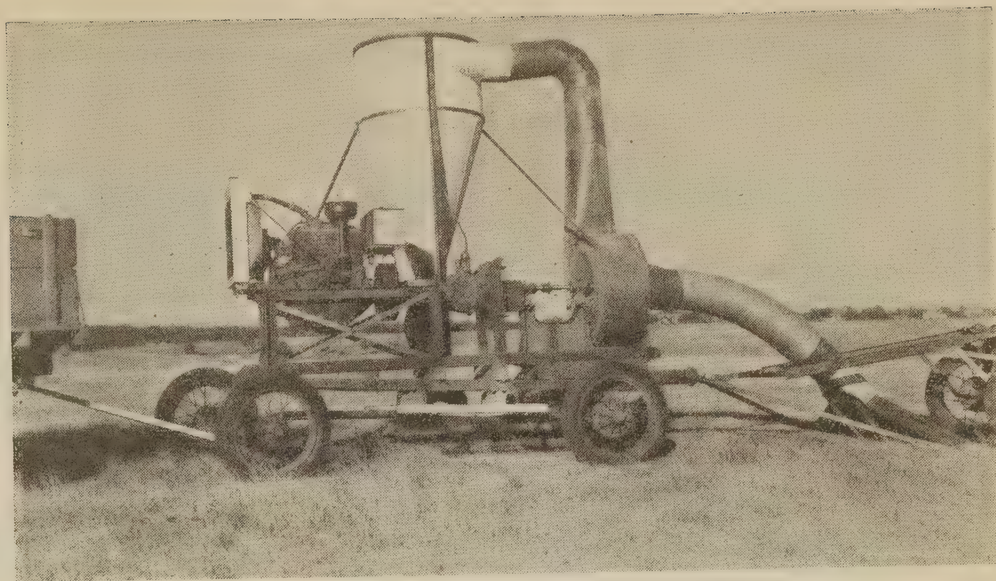
The stolons or runners reach out and fasten themselves down at the nodes. This method of propagation tends to increase the percentage of ground cover, to supply more grazing, to smother weeds and to protect the ground surface. The result is better pasture and soil protection. The idea of establishing the grass vegetatively has been considered and tested, but the method is expensive and sod is not available in sufficient quantities.

In Buffalo grass pastures both male and female plants are found, the female bearing the seed. These plants are not evenly distributed, but occur in patches of



Buffalo grass seed harvesting machine of the vacuum principle assembled at Kansas State College, Manhattan.

Buffalo grass seed harvesting machine of the vacuum principle assembled at Hays, Kans.



varying size. In an area where female plants predominate, a concentration of seed is found; whereas in an adjoining area the male plants may predominate and little, if any, seed can be obtained. Such a condition makes it difficult even to estimate the yield per acre.

Seed is produced throughout the growing season from early summer until frost. While there is, therefore, no definite harvest season, the largest quantity of seed may be obtained in the fall or late summer.

The caryopsis is in a small burr produced on the stem down among the curly grass blades. The burr is of tough fibrous material made up of one or more parts, usually two or three; each part may or may not contain a caryopsis. On one end of the burr are small, pointed, spreading projections which cause the burr to cling to the grass blades. As these small burrs mature and dry, they fall to the ground or drop at the slightest jar. Preliminary germination tests made by Government and other seed laboratories show a germination ranging from 5 to 65 percent. With these facts in mind we come to the problem of harvesting.

Perplexing Problem

The job is not simple, as in designing a machine nothing may be incorporated that would in any way damage the pasture. The idea of a vacuum device was first tried out at Chillicothe, Tex., in the fall of 1934. The test was inadequate and, so far as I know, the invention was not developed further.

The problem of a practical seed harvester was presented to Frank J. Zink, associate professor of agricultural engineering at Kansas State College, and L. C. Aicher, superintendent of the experiment station at Hays, Kans. The former had developed a machine of promise, and the latter had been thinking along the lines of our need. Buffalo grass pastures were readily accessible to both men for trial tests.

Because of the seeding habits and plant characters of Buffalo grass, it could not be determined in advance just how difficult it would be to gather the seed. Changes in the mechanism were based upon general observations, and it was not until a reasonable degree of efficiency was reached that accurate records were made of its performance.

Specifications of the Manhattan machine follow: Power, tractor power take-off; automobile transmission; fan, 24 inches by 8 inches; revolutions per minute, 1,000; intake pipe, 8 inches; nozzle, 5 feet by 8 inches, equals 480 square inches.

This contraption was mounted upon a 2-wheel trailer, and a dust-collector was added.

Chain Drag Tried

An examination of the ground and plants before and after operation of this machine indicated that a small percentage of the seed had been gathered. It was clear that the seed must be loosened from the plants and from slight imbedment in the soil. To accomplish this end, a chain drag was suggested. This side wall chains used on automobiles, about 3 feet long, were nailed about 1 inch apart to the 2 by 4 and attached ahead of the nozzle.

By this means many more seed were loosened, but still the machine did not lift the seed. It was concluded that a greater volume of air and increased veloc-

ity were necessary. A home-made furnace cleaner, believed to be large enough for the job, was therefore given a trial.

A description of this unit follows: Power, motor; two fans, each 24 by 10 inches; revolutions per minute 1,500; intake, 12 inch; nozzle, 5 feet by 8 inches, equals 480 square inches.

This machine, with and without the chain drag, gathered considerably more material but the percentage of seed taken up continued to be small.

At this point four new nozzles were designed, of the following dimensions: (1) 5 feet by 8 inches, equals 480 square inches; (2) 8 feet by 8 inches, equals 768 square inches; (3) 6 feet by 4 inches, equals 268 square inches; (4) 6 feet by 2 inches, equals 144 square inches.

No. 3 nozzle cut on a 45° angle at the point of contact with the ground. This nozzle was constructed of wood, tongue and groove material. Into one side a 12-inch pipe was fitted, adapting it to the pipe on the furnace cleaner.

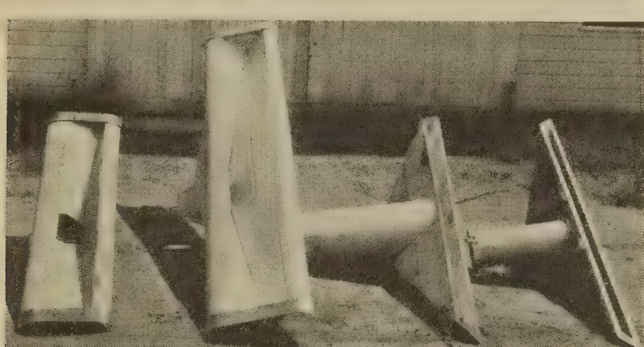
Results Better

The results were much better with this contrivance. More foreign material was collected and more than 50 percent of the seed was taken up.

To determine the proportion of seed lifted by the machine, small rectangular areas were marked off on the ground with a blunt tool or pencil and the seed in the area counted before and after the machine was passed over it. No attempt was made to have all areas the same size; they varied from 4 to 144 square inches.

With the machine approaching expectations, the wooden nozzle was attached to the first machine.

The percentage of seed obtained then was arrived at in the same manner as before. Approximately 30 percent was taken up, indicating that more power and a greater volume of air with increased velocity was required.



Types of nozzles used on vacuum machines constructed at Manhattan, Kans.

Thereupon, the fan was increased and a power unit mounted on the trailer and hooked directly to the fan through the transmission. This allowed the forward speed to be reduced and the fan revolutions per minute increased.

The new specifications read: Power, 4-cylinder gas motor; fan, 3 feet by 12 inches; revolutions per minute, 1,500; intake, 12 inches; nozzle, 6 feet by 4 inches, equals 288 square inches.

With this arrangement, 57 percent of the seed was picked up where too much top growth or foreign material did not interfere. That the efficiency of the machine is determined by the amount of top growth present will be clearly pointed out after a brief description of a similar machine assembled at Hays: Mounted upon a 4-wheel trailer; pneumatic tires; power, 4-cylinder, 20-horsepower motor; automobile transmission; fan, 30 inches by 10 inches; intake, 12 transmission; fan, 30 feet by 10 inches; intake, 12 inches; brush, 7 feet by 18 inches, with 8-inch maple core, 3-inch opening for shaft, 5-inch flexible fibers, revolutions per minute about 150; fan revolutions per minute, 2,200; brush rotation, clockwise, driven from axle.

Considerable foreign material, but a very small percentage of seed was picked up.

With the brush reversed and its revolutions increased to 350 per minute, using a nozzle 7 feet by 6 inches (504 square inches), the volume and velocity of air was not enough to clear the nozzle of heavy foreign material, principally cactus and cow chips which clogged the nozzle and did not allow lighter materials to be passed.

By removing the brush and attaching a 6-inch rubber belt to the back side of the nozzle, a better suction was maintained over slight depressions in the ground. Counts made as before showed approximately 40 percent of the seed taken up.

The belt was removed, allowing more air to pass under the back edge of the nozzle. This increased the efficiency of the machine about 8 percent. The machine was not yet meeting our needs, so the number of square inches in the nozzle was cut from 540 to 288 at the point of contact on the ground. This was done by fitting two pieces of wood inside the nozzle 18 inches from each end and sloping them toward the intake pipe. Counts indicated that this

(Continued on page 13)

BUILDING TERRACES TO FIT THE ROTATION PROGRAM

By Ernest Carnes

Within the next year or two the Soil Conservation Service will test the practicability of constructing terraces in South Carolina with ordinary horse-drawn equipment.

It is estimated that it would require the services of 100 tractor units 20 years to construct all the farm terraces that are needed in the Piedmont section of South Carolina.

Although terracing is but one of the control measures in the coordinated soil conservation program, it is highly important because of the fact that such a large acreage is devoted to clean-tilled crops.

Recently the S. C. S., in cooperation with technicians of 14 E. C. W. camps, located approximately 50 demonstration fields on farms of cooperators in South Carolina, of from 5 to 30 acres each, well suited to the proposed system of progressive terrace construction with horse-drawn machinery. Fields not badly gullied and with slopes of from 3 to 8 percent were chosen, leaving the steeper inclines for power outfits.

Plans for water disposal were made by engineers or erosion specialists. Terrace lines were established. The cooperator used implements common to the average farm, such as a two-horse turn-plow with three mules to pull it. An extension moldboard is, however, more satisfactory. The plow should be heavy enough to penetrate the subsoil.

Several Plowings Necessary

It is estimated that it will be necessary to plow up these ridges four to seven times to gain the necessary height and width for a satisfactory terrace. Special attention should be given to building up low places in the terrace ridges. This work will be done by the farmer himself over a period of 2 to 3 years, covering a complete rotation.

If the method is to be successful, the cropping system must be planned so that the maximum amount of vegetation will cover the fields during the early stages of construction. In order not to disturb the usual rotation of cotton, grain, and corn, terrace construction will be begun during the fall when grain is to be planted.

Work started in October and November of 1935 will conform to the following program:

(1) The water-disposal system will be made, the terrace lines surveyed, the terraces plowed, and the entire field sowed to oats, barley, or wheat.

(2) In February or March 1936 lespedeza will be sown between the terrace ridges on the grain, but not on the ridges.

(3) The grain will be harvested in June 1936, and the ridges plowed again. This will not disturb the lespedeza. The terrace ridges will be sown to sorghum or Sudan grass for hay.

(4) In the fall of 1936 the hay crop will be harvested from the ridges and the third plowing will be done. The ridges may be sown to a winter cover crop of grain, vetch, or Austrian winter peas. The lespedeza may be harvested for hay or seed and the stubble left for winter protection.

(5) In April or May 1937 the fourth plowing will be done, plowing under the cover crop, and planting to a summer hay crop. The area between the terrace ridges (lespedeza sod) will be plowed under and planted to corn, interplanted with soybeans or cowpeas.

(6) During the fall of 1937 the hay crop from the ridges will be harvested and the fifth plowing of the terrace ridges will be done.

(7) In the spring of 1938 the sixth plowing of the ridges will take place, after which the entire field, including the terrace ridges, will be prepared and planted to cotton, the third and last year of the rotation cycle.

There are a number of advantages to this method of terrace construction:

(1) No initial cash expenditure is involved.

(2) With the exception of the "panning-up" of low places, no extra labor is required, as the land must be plowed anyway.

(3) The maximum vegetation is had at the time when the terraces are least effective.

(4) The rotation system is not disturbed, providing the terracing is started concurrently with the grain in the rotation cycle.

(5) A sod is turned under at each plowing, which will result in more substantial terraces.

ENGINEERING STRATEGY IN A WIND-EROSION AREA

By L. C. Tschudy

A result of wind erosion.

Our engineers have their work cut out for them here in the drought-scourged, wind-whipped expanses of the Dakotas. But in valuable partnership with them, and with the other soil-conservation specialists engaged in the erosion-control and water-conservation program, is the indomitable spirit of a people who will not be beaten by repeated disaster. They have farmed with energy and a faith which literally has "moved mountains"—mountains of sand piled against barns and houses and fences, obliterating roads and bringing desolation to thousands of acres of a once productive agriculture. Their wives and daughters have patiently "swept out" following innumerable dust storms, loyally seconded their men in facing the future with hope and courage.

Dakota farms will continue to make crops. Hereafter when the rain fails and the winds blow, many of them will remain anchored and drought-resistant because of engineering devices used in supplementing agronomic measures of wind-erosion control. Briefly, I will sketch what we are doing.

Procedure Outlined

First the farm is visited by a Soil Conservation contact man. He works out a new plan, revises the rotation system with an eye to cover crops, provides for strips laid at right angles to prevailing winds. Soil drifts must be leveled, seeding must be followed by listing. There may be need for level terraces to conserve water or for a small water-conservation reservoir. In any case, if the farmer needs such work and offers his cooperation, the Soil Conservation Service will carry through the job. The contact man makes a detailed report for the engineers, gives a rough estimate of what is required for retaining rainfall and resisting erosion.

The field engineering classifies as (1) leveling fields and preparing them for crops (2) level terracing for retention of water, and (3) small dam construction.

When our program began, we found that many fields had blown to such an extent that no cover crops would catch without a roughening of the surface. Huge drifts were collected along fence lines, a menace to wind-erosion control. Many of the fences were buried.

Smoothing the Ground

We are following the practice of using heavy equipment to level drifts—a tractor and blade. First we level these drifts up to the fence line, then remove the fence and level the other half of the drift. The fence is then replaced and the entire field is usually listed for seeding to rye, wheat or oats. Where movement of the soil is not so serious, cultivating and seeding will make a cover crop possible.

The general purpose of terracing is to assist in the control of water erosion. If our engineers decide upon this method of treatment, a soil survey is made for guidance.

When soil is of slow infiltration, water is likely to stand in the terrace for a longer time than is desirable. In such a case the terraces are made with a slight grade so that the water will flow off the channel before it drowns a crop. When, on the other hand, the soil is of fast infiltration, the terrace is designed without any grade. Thus a good part of the run-off will be stored on the field. In either instance, the water will be slowed down so that more of it will seep into the soil.

The ends of the terraces are left open. This provision is to avoid flooding of crops or over-topping of terraces. Later, if the farmer wishes to close these ends during

a dry season, that can be done. Our operations are conservative. If there is uncertainty as to whether or not the soil will absorb the moisture in sufficient time to prevent drowning of the crop, we make the terrace with a slight grade over the last 500 feet.

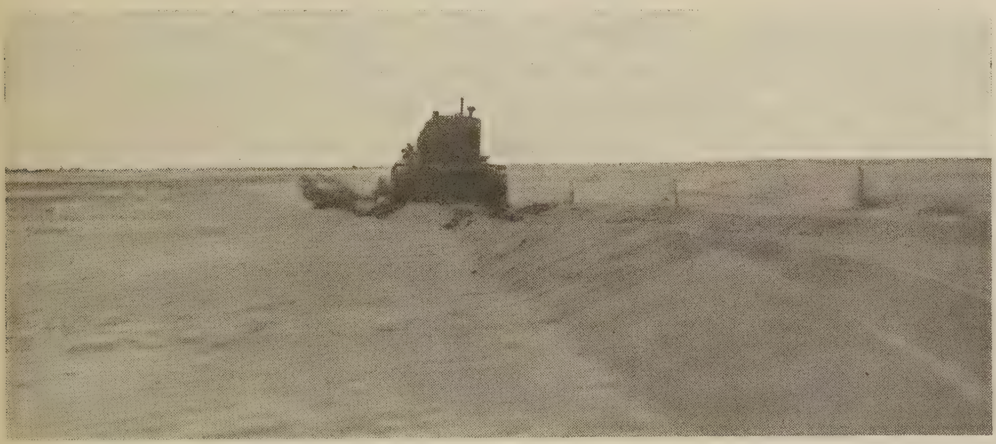
Cost Records Kept

Accurate cost records are kept throughout, including topographic map, survey, time, heavy equipment and finishing. W. P. A. labor is being used to advantage in the construction of dams. Cooperating farmers furnish sand and cement for rubble masonry spillways, teams and teamsters for placing the fills, or for plowing in preparation for fills. The Soil Conservation Service furnishes engineering supervision, investigation, and plans.

This arrangement results in the farmer sharing a good portion of the cost of each dam.

Small dams are very much in demand in this area, and the entire erosion-control program is looked upon with favor by a community that is determined to prepare for the next great drought.

Typical of the fence drifts.



Heavy equipment leveling drifts.

(Continued form page 10)

machine gathered about 60 percent of the seed. A this point, there was very little difference in the efficiency of the two models.

The consensus of opinion was that a much greater percent of the seed could be obtained if the top growth were mowed and removed. This had been suggested a number of times. To test the theory, a lawn mower with a grass catcher was taken to a pasture and small areas were clipped.

Summary

Machine	Nozzle	Treatment	Number of areas	Total seed	Seed left	Percent harvested
	Square inches					
Hays	540	Belt on nozzle [1]	[2] 4	152	91	40
Do	540	Belt removed	4	142	74	48
Do	288	Grass clipped, 1 inch.	5	249	13	95
Do	288	Clipped, 1 inch	5	103	28	72
Manhattan	288	....do	4	104	33	68
Do	288	....do	5	92	28	66
Do	288	Not clipped	7	240	103	57

[1] 6-inch rubber belt attached to rear edge of nozzle. An average of 34 counts indicates an overall efficiency of 63.7 percent.
[2] Number of areas in which counts were made before each test.

(Concluded on page 14)

HALTING ITALY'S SHIFTING SANDS

By Albert Chiera

(Pictures on Opposite Page)

EDITOR'S NOTE.—This article, like the one by the same author in the November issue, is presented solely in the interest of a broader understanding of erosion control practices. Soil science knows no international boundaries. Mr. Chiera is a translator and research assistant in the Soil Conservation Service, and his contribution is a by-product of extensive reading of erosion control literature.

Among the plants to which nature has assigned the task of restoring devastated land, the *Arundo arenaria*, or weed of the sand, is of particular interest. It can live partly buried in sand, with its roots exposed to hot winds. Moving sand is halted by this plant, forms small mounds around it; the roots seek the air, vegetate and repullulate near the surface, and check the migration of still other sand.

It does not follow, however, that this or any other plant will be able to reconquer the lost mantle of vegetation over desert areas without the help of man.

Experience of Other Countries

Egidio Ferrari in the second chapter of his Boschi e Pascoli states: "The change that the climate in Persia underwent after the destruction of its numerous and majestic parks is well known; its territory was transformed into movable banks of white sand, the climate became arid and suffocating, springs of water at first decreased and finally disappeared altogether. Egypt, with the devastation of its forests, saw a decrease in rains, in soil fertility, and in uniformity of its climate. Palestine, at one time covered with valuable forests and fertile pastures, possessed also cool and moderate climate; today its mountains are sadly denuded; the rivers almost dry and crop production reduced to a minimum."

It is clearly seen that the cooperation of man is essential to combat erosion. Some of our most useful plants are not native ones. For example, alfalfa, which is an Oriental plant, was brought to Greece from Persia about 590 B. C. and entered the United States of America from the West at the time of the gold discoveries.

Grasses alone, whether native or foreign, are often insufficient to stop wandering sand dunes. To secure permanent living cover, we also resort to scrubby shrubs, forest trees, and physical means. The fixation of drifting dunes by a special artifice is essential under extreme conditions.

The Italians, as shown in the upper picture on the opposite page, have found a way of solving the problem by imprisoning sand in fences placed close together, forming corridors within which forest plants are protected during the early stages of their growth.

In the lower view a similar principle is exemplified somewhat differently. A light fence is covered with living vegetation planted in squares which check the wind and hold the sand in place. Forest plants, whether seeded or transplanted are thus given an opportunity to live and grow.

Arnaldo Fanti in his book La Tecnica e la Pratica Delle Bonificazioni, gives in chapter VI a list and description of the plants found most suitable for this work. I quote this list herewith, believing that some of them, if indeed not already used, might be found valuable in a work of this kind in the United States:

Herbaceous plants.—*Arundo arenaria, salicornia herbacea, salicornia fruticosa, chenopodium album, agrostis maritima, triticum glaucum, pteris aquilina, agave america* and *opuntia*.

Shrubs and trees.—*Juniperus communis, tamarix gallica, pinus maritimus* and *pinua pinea*.

(Concluded from page 13)

Conclusions

1. Buffalo grass seed may be gathered with a vacuum machine.

2. Machines of this design will harvest from 50 to 60 percent of the seed under average conditions and will not damage the pastures.

3. For best results, pastures moderately to heavily grazed must be selected from which to harvest seed. A chain drag used on pastures of this nature will slightly increase the amount of seed obtained.

4. Mowing pastures will not be feasible because of added expense and lack of available pastures where mowing would be permitted even at rental prices.

5. The efficiency of the machine will be determined by the density of turf and how securely the seeds are embedded in the soil.

Above: Reforestation by Alepensis *pine.* *Below: Damming drifting dunes.*

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

A contribution from the Soil Conservation Service Library

REPORT OF H. H. BENNETT, Chief of the Soil Conservation Service, to the Secretary of Agriculture. September 26, 1935. Washington, D. C.

Reestablishment as a permanent bureau of the Department of Agriculture, assuring as it does the coordination and continuation of national effort to preserve soil resources, was, to the Service, the most significant development of the year. This transition from an emergency agency to a permanent bureau entailed reorganization and reshaping of policies, and at the same time a broad expansion of activities. Summarily stated, the objectives of the Service are, to propagate the use of soil conservation practices in agriculture through the medium of demonstration; in so doing, to effect a maximum control of erosion on as large a land scale as is possible; and to collect fundamental scientific facts essential to the development and improvement of soil-conservation method and technics.

As a functional approach to each of these objectives the program of the Service is divided into distinct but interrelated fields of activity, involving (1) the field demonstration work, (2) actual cooperative work with land owners, and (3) a consistent development and improvement of all measures through research and investigation.

Tables included in the report present the geographical and acreage distribution of projects, cooperative agreements, special field work completed, assignments to emergency conservation camps, divisional data resulting from surveys, and erosion wastage. Concise summaries of three important projects are given; namely, the Navajo, the Gila River, and the Rio Grande projects.

The report sets forth clearly the organization plan of the Service, with objectives and work of divisions, sections, units, their duties and interrelationships. A brief personnel and expenditure reconnaissance is included at the close.

MANUAL OF THE GRASSES OF THE UNITED STATES. By A. S. Hitchcock. United States Government Printing Office, Washington, 1935. 1,040 pages.

This is an accomplished and concise description of the grasses of the United States, with distribution and utility notations which make it particularly valuable to the practical botanist. There are 159 numbered genera and 1,100 numbered species. Many authentic sources have been utilized by the author in solving the problems of puzzling species and varieties.

Of special interest to the Soil Conservation Service are the soil-holding grasses which possess strong creeping rhizones. In Dr. Hitchcock's book are to be found illustrated descriptions of the most effective sand-binders, namely the European beachgrass (*Ammophila arenaria*) and its American relative (*A. breviligulata*); *Calamovilfa longifolia* and *Red fieldia flexuosa*, the native sand binders on sand dunes of the interior; Bermuda grass and quackgrass (*Agro-pyron repens*) used successfully to hold the sides of cuts and banks; and rhizone-bearing species of *Elymus* and *Agrophron*, which are efficacious in holding railway embankments along the Colombia River.

Grasses playing an important part in coverting marshes and mud flats into dry land, especially species of *Spartina* and *S. townsendii*, are described in detail and illustrated by fine drawings made from specimens. Many range and pasture plants are represented, as well as hay, silage, ornamental, soiling, and industrial arts grasses.

A useful feature of the book is its accented syllable markings to aid the user in pronouncing the Latin names.

At the close of the classification section appears a synonymy. For quick reference the names of genera and valid species are arranged in alphabetic order, the names in blackface type. The synonyms, in italics, are arranged chronologically under the names to which they are referred.

A glossary of botanical terms is included, and a most comprehensive index with synonyms in italic type.

This manual, the final work of the late Dr. Hitchcock, is a suitable monument to a great botanist.

We have in the Soil Conservation Service Library a limited number of copies of this book which may be taken on loan for use in the field.

USE OF IRRIGATION WATER AND IRRIGATION PRACTICES. VOLUME I. By B. A. Etcheverry and S. T. Harding. Second edition, 1933. 100 illustrations.

This is the first volume of a three-volume series, entirely rewritten for the second edition. The authors present the essential features of good irrigation practice, with sufficient material regarding the subjects to support the principles set forth. Results of individual experiments are used to illustrate the principles of practice. The book contains chapters on physical properties of soils; water requirements of irrigated crops; general water requirements; preparation of land for irrigation, and method of application; farm distribution systems, and the selection and cost of small pumping plants.

ELEMENTS OF FOREST MENSURATION. By Herman H. Chapman and Dwight B. Demeritt. 1932.

A new method of presenting this subject, with these conspicuous features: It begins with the product and its measurement, follows this product into the log or bolt, totals the contents of these pieces to obtain tree volume, shows how this volume can be measured in standing trees and finally discusses the problems of measurement of the product in a stand of timber and on large areas of land. 422 pages. Bibliography. Appendix. Index.

THE MODERN NURSERY. By Alex Laurie and L. C. Chadwick. 1931.

An up-to-date and thoroughly complete manual of the handling of plants as practiced in the present-day commercial nursery. 494 pages. Illustrations. Index.

U. S. GOVERNMENT PRINTING OFFICE: 1936

AVAILABLE SOIL CONSERVATION PUBLICATIONS

All publications listed are available to members of the staff of this Service, to other Government bureaus whose duties make it necessary for them to have such information, and to cooperators of the Department of Agriculture engaged in soil conservation activities. General bulletins only are available for general distribution in limited quantities.

GENERAL

Cost of Soil Erosion. H. H. Bennett. Address before Illinois Farmers' Institute. February 22, 1934.

Erosion A National Problem. H. H. Bennett. Address before Ohio Valley Improvement Association. December 12, 1934.

Facing the Soil Erosion Problem. H. H. Bennett. Address before Association of Southern Agricultural Workers. February 1, 1935.

Man-Made Deserts. W. C. Lowdermilk. Reprint from Pacific Affairs. Vol. VIII, No. 4. SCS–MP–4. December 1935.

Problem of Water and Soil Conservation. H. H. Bennett. Address before Iowa State College. WOX Broadcast. February 8, 1935.

Relation of Soil Erosion to Flood Control. H. H. Bennett. Address before National Rivers and Harbors Congress. April 30, 1934.

Relationship of Extension Service to Soil Conservation Service. H. H. Bennett. Address before 49th Annual Convention of Association of Land-Grant Colleges and Universities. November 18, 1935.

Resume of Activities of the Soil Conservation Service under Department of the Interior. Statement. May 1935.

Soil Conservation. H. H. Bennett. Address before National Editorial Association, New Orleans, La. May 4, 1935.

Soil Conservation. Periodical. Vol. I; no. 1, August; no. 2, September; no. 3, October; no. 4, November; no. 5, December.[1]

Soil Erosion and Its Control in the United States. W. C. Lowdermilk. Paper presented at plenary session of Third International Congress of Soil Science. SCS–MP–3. November 1, 1935.

Soil Erosion Bibliography. Lillian H. Wieland. 1935.

Tragic Truth About Erosion. H. H. Bennett. Reprint of article in New York Times of June 17, 1934. Issued by Forest Preserve Association of New York State, Inc.

Suggestive List of References on U. S. Soil Erosion Service and Its Work. James T. Rubey. Bibliographical List No. 4, Geological Survey. January 15, 1935.

The Land: Today and Tomorrow. Vol. 2, no. 4, April, 1935. Monthly magazine. (Publication discontinued.)

Wildlife and Erosion Control. H. H. Bennett. Address before National Association of Audubon Societies. October 29, 1935.

TECHNICAL

Outline of Investigational Work in Progress and Brief Summary of Principal Results for Four Year Period 1931–34. B. H. Hendrickson and Ralph W. Baird. Soil Erosion Experiment No. 4, Tyler, Texas. SCS–EP–3. August 1935.

Outline of Investigations and a Brief Summary of Results on the Red Plains Erosion Experiment Station, 1930–35. Henry G. Lewis. SCS–EP–7. November 1, 1935.

Preliminary Report on Beneficial Uses of Water Resources, Principal Streams of the United States. H. H. Bennett and W. C. Lowdermilk. March 19, 1934.

Reconnaissance Erosion Survey Data. SCS–MP–2. July 8, 1935.

Soil Erosion and Flood Control. H. H. Bennett. Lectures before Graduate School of the U. S. Department of Agriculture. Lecture I, January 30; Lecture II, February 1; Lecture III, February 3, 1928.

AGRONOMIC

Grass in Soil Erosion Control. Lyman Carrier. Mimeo. 1934.

Improvement of Permanent Pastures. Lyman Carrier. Mimeo. 1934.

Strip Cropping. Lyman Carrier and Walter V. Kell. SCS–TP–2. Revised, 1935.

AGRICULTURAL ENGINEERING

Brief Instructions for the Design and Construction of Small Dams for Emergency Conservation Work in North Dakota. L. C. Tschudy and John G. Sutton. SCS–EP–8. November 1935.

Brief Instructions on Methods of Gully Control. C. E. Ramser. SCS–EP–10. November 1935.

Diagrams for Use in Hydraulic Design of Erosion Control Structures. H. L. Cook. Mimeo. 108. February 1935.

Engineering Practices and Standard Plans for ECW Erosion Control Camps. W. D. Ellison. April 1935.

Memorandum for ECW Camps in Nebraska Relative to Terraces and Other Erosion Control Structures. C. A. Frye and I. D. Wood. SCS–EP–11. November 1935.

Memorandum to ECW Technicians on the Design and Control of Broad, Shallow, Terrace Outlet Ditches. W. D. Ellison. SCS–EP–9. November 1935.

Outline and Summary of Engineering Experiments on Erosion Control on the Ten Soil Erosion Experiments of the U. S. Department of Agriculture. SCS–EP–1. August 1935.

Proceedings and Recommendations of February Conference of SES and ECW Engineers. Volume 1. Minutes. February 1935.

Proceedings and Recommendations of February Conference of SES and ECW Engineers. Volume 11. Papers. February 1935.

Terracing Problems in the North Central States. G. E. Ryerson. Mimeo. 319. February 1935.

[1] On sale, Superintendent of Documents, Government Printing Office. $0.10 per copy, $1 yearly, domestic.

SOIL CONSERVATION

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UNITED STATES DEPARTMENT OF AGRICULTURE · WASHINGTON

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WELLINGTON BRINK — EDITOR

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

H. H. BENNETT
Chief, Soil Conservation Service

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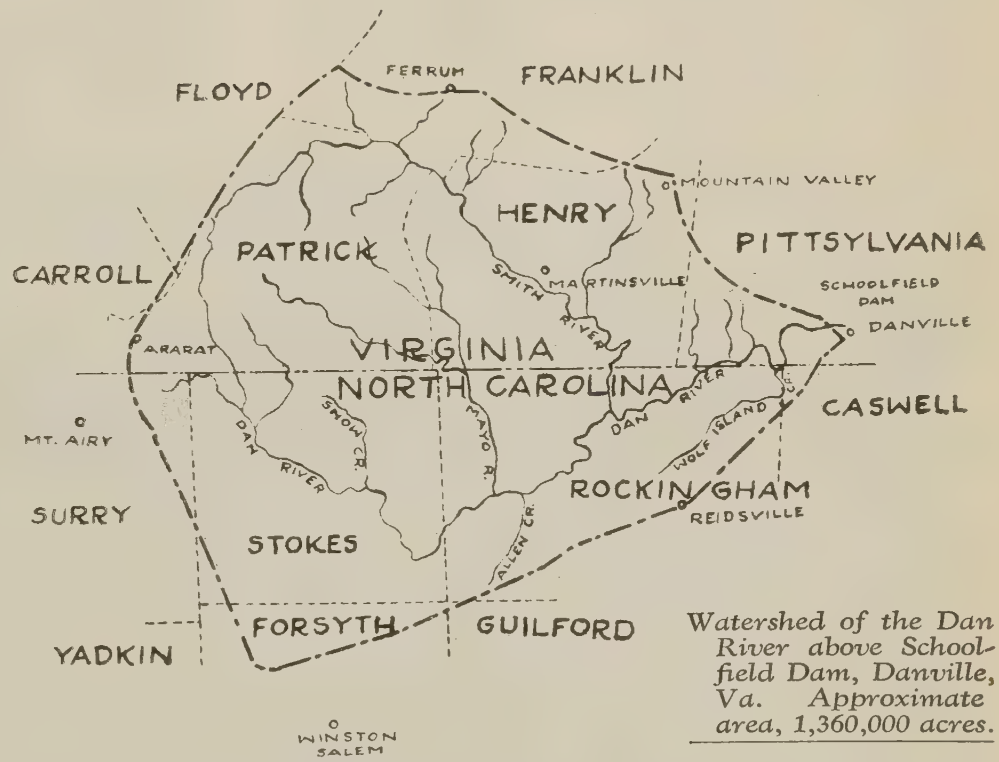
ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON

TWO CENTURIES OF ACCRUING TRAGEDY ALONG THE DAN RIVER

By P. F. Keil

The first white settlement in Virginia was made by Whitman in 1607 on the James River. Very few hunters and traders reached the Piedmont section before Colonel William Byrd II made the survey of the dividing line between Virginia and North Carolina in 1728. Colonel Byrd wrote a description of the river and its drainage area. Near the present site of Danville he found carved on a birch tree, "J. H., H. H., and B. B. lay here 24th of May, 1673." John Hatcher, Henry Hatcher, and Benjamin Bullington were early traders and famous woodsmen.



Watershed of the Dan River above Schoolfield Dam, Danville, Va. Approximate area, 1,360,000 acres.

Colonel Byrd, in his description of the area, said:

> Happy will be the people destined for so wholesome a situation, where they may live to fullness of days, and which is much better still, with much content and gaiety of heart.

Inviting Prospect

Colonel Byrd spoke of the Dan River Valley as the "Garden of Eden." Said he:

> The air is wholesome and the soil equal in fertility to any in the world. This charming valley will bring forth like the lands of Egypt, without being overflowed once a year. The grass in the river section grows as high as a man on horseback. The river, about 240 feet wide, always confined within its lofty banks, and rolling down its waters as clear as crystal. The stream, which is perfectly clear, runs about two miles an hour. The bottom is covered with coarse gravel, spangled very thick with a shiny substance that almost dazzles the eyes and the sand on either shore sparkles with the same splendid particles. At first sight, the sunbeams giving a yellow cast to these spangles, made us fancy them to be gold dust, and that consequently all our fortunes were made, but we soon found ourselves mistaken and our gold dwindled into small flakes of isinglass. However, this does not make the river as rich as we could wish, yet it makes it exceedingly beautiful.

43149—36

Throughout Byrd's History of the Dividing Line and The Secret History, he continually refers to the richness of the soil in the areas drained by the James, Meherrin, Nottoway, Staunton, and Dan Rivers with their tributaries. Such references as the following are numerous:

> The *Soil* we past over this *Day* was generally very good, being cloath'd with large *Trees*, of Poplar, Hiccory and Oak. But another certain Token of its Fertility was that wild Angelica (*Archangelica atropurpurea*) grew plentifully upon it.
>
> * * *
>
> That the Soil brings forth Corn Spontaneously, without the Curse of Labour, and so very wholesome that none who have the happiness to eat of it are ever sick, grow old or dy.
>
> * * *
>
> The Soil where the Locust Thicket grew was exceedingly rich as it constantly is where that kind of Tree is Naturally and largely produc'd.

Wild turkey, deer, partridge and other game was plentiful. The surveyors supplied their entire meat requirements with little effort. Cherries, wild plum, wild grapes, other berries, seed-bearing trees, plants, vines and shrubs furnished a good food supply.

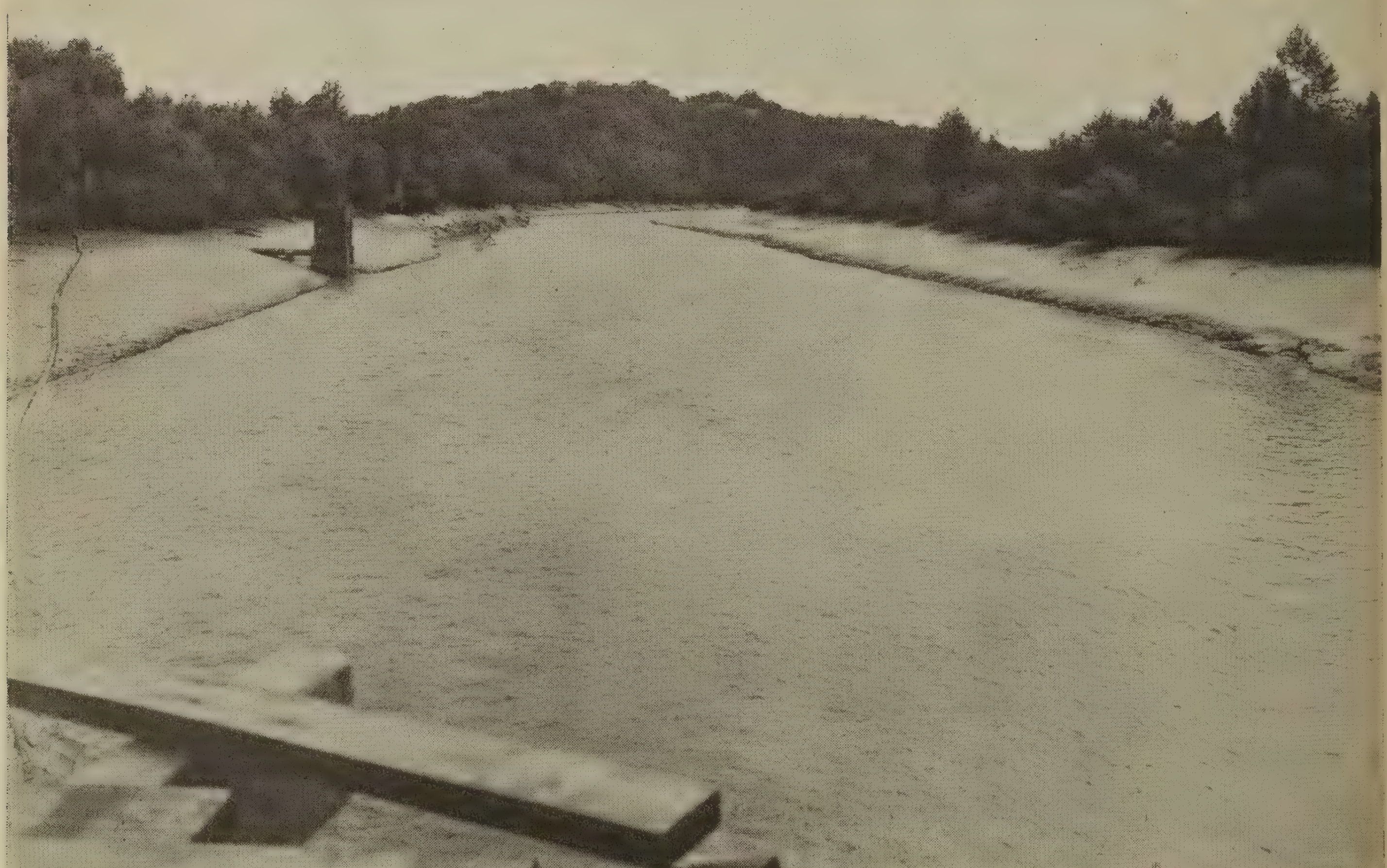
A camp was established by Colonel Byrd at Wynne's Fall. The planters came annually to fish for the sturgeon in the Dan, and to talk with old friends. A permanent settlement was not made in Pittsylvania County, however, until about 1746. Wynne's Fall, by an act of the Virginia Legislature November 23, 1793, became Danville. Colonel Byrd had named the Dan, and the legislature named the town on its banks for the "charming river" over which Colonel Byrd rhapsodized in his history of the Dividing Line. From this date on, the number of settlers increased rapidly until the greater part of the county was cleared. As shown by the records of tobacco sales in the clerk's office in Chatham:

> A list of tobacco records at Danville Warehouse from October, 1797 till September, 1798 one hundred and ninety four Hhds. and remain 34 in warehouse and 2116 pounds of Transfer tobacco. (A total of 275,716 lbs. of tobacco).

High Production

Quoting from historical collections of Virginia by Henry Howe, published in 1845 by Babcock & Co., Charleston, S. C.:

Looking upstream, east side of island and main channel of river. The structure at the left is the intake for the city water supply; when built in 1904 it was in the main channel of the stream.



Pittsylvania County, Virginia, was formed in 1767, from Halifax. It is 35 miles long and 26 broad. It is watered by the Staunton on the north, the Dan on the south, and Banister River in the centre: Much of the soil is excellent and produces annually over six millions of pounds of tobacco, besides heavy crops of grain. Danville is a large village on the Dan River, with a population of about 1500.

The canal of the Roanoke company around the falls of the Dan River is about one mile long, which affords eligible sites for manufactories to almost any extent, with abundance of water-power at all seasons. The river is navigable for batteax carrying from 7,000 to 10,000 pounds as far up as Madison, North Carolina, 40 miles distant. With some slight improvements, the river is supposed to be susceptible of steamboat navigation to the town.

In this same book we read:

Amelia County, Virginia. It is drained by the Appomattox River. The surface is agreeably diversified; the soil on the hills poor and usually much worn, on the bottoms fertile, and it has generally much deteriorated from its original fertility, owing to the injudicious modes of cultivation pursued by its early settlers.

Bedford County, Virginia. The surface is uneven and the *soil is naturally very* fertile, but has been injured by the injudicious cultivation of tobacco.

Campbell County, Virginia. Its surface is broken and its soil productive. Staunton River runs on its south and the James on its northwest boundary, *both of these streams are navigable for boats far above the county limits, thus opening a communication with Chesapeake Bay and Albemarle Sound.*

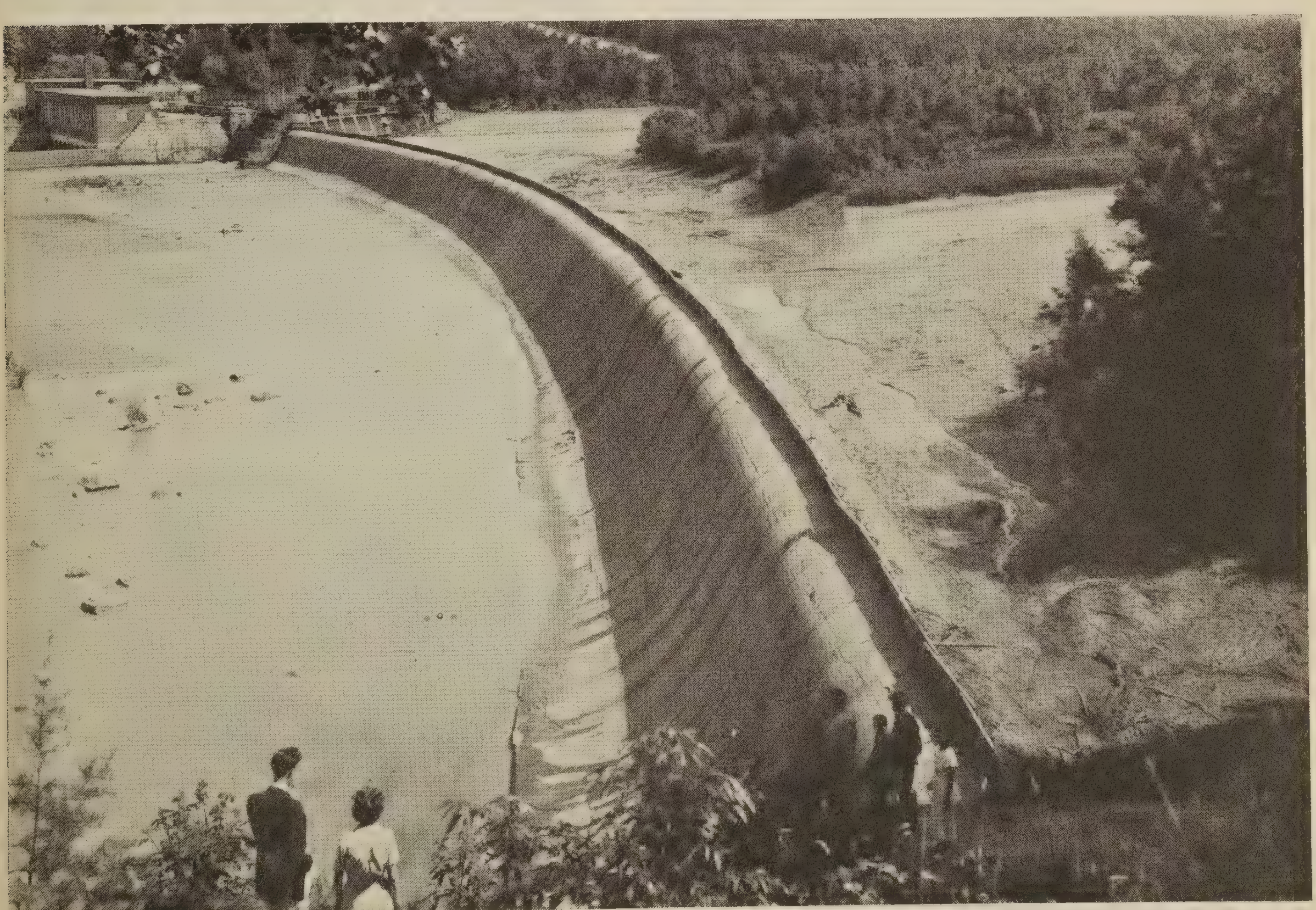
In 1845 Howe said of Rockbridge County, Va.:

Much of the soil is of superior quality and highly cultivated. It is one of the most wealthy agricultural counties in the state. * * * Spottsylvania County, Virginia. The soil on the streams is fine.

Erosion Takes Nearly Half

One hundred forty-two years have elapsed since Danville was named, and 189 since the first settlement was made in Pittsylvania County. It is estimated that 85 percent of the drainage area of Dan River was once cleared. The area above the Schoolfield Dam contains 1,360,000 acres, 1,153,000 having been cleared, and only 15 percent, or 204,000 acres, having remained in virgin forest. However, 40 percent, or 544,000 acres, has been allowed to go back to forest, due to erosion. Until recently, little thought had been given to the idea of holding the soil and plant food on the farms; consequently the soils have washed away.

View from north end of dam, with water drained off. The flood gates are raised every month to prevent the remaining water channels from being entirely filled with silt.



A silent reminder that erosion is a relentless foe.

Dan River and Smith's River have as their sources two beautiful springs within throwing distance of each other in Patrick County, Va., on the Blue Ridge Plateau over 3,000 feet above sea level. They are fed along their routes by other springs—all cool, clear, lovely.

This watershed, belonging to the Dan and its tributaries, drains four counties above Danville, Patrick and Henry in Virginia, and Stokes and Rockingham in North Carolina. It is 95 miles from source to Schoolfield Dam. The Dan is naturally clear, except in time of freshets, until after it leaves the plateau. In fact, it is clear until it enters Stokes County. From there on it is of reddish hue.

Conditions Radically Different

No longer can be seen the shiny glitter that once caught Colonel Byrd's eye. A swimmer emerges with a copper-colored skin. A fisherman reconciles himself to a few mud cats, suckers and carps; the clear-water game fish are not to be found below the plateau region.

The Dan today is carrying millions of dollars worth of plant food and soil from the drainage basin; it is making farms poorer and poorer each year; families are being driven from their homes in order that they may make a living elsewhere; estates are being divided and sold. One is led to wonder what Colonel Byrd would say if he could live again and visit the one-time "Garden of Eden."

The Schoolfield Dam, just above Danville, furnishes evidence of the rapidity of erosion throughout the watershed. It was completed in 1904. It is 1,150 feet long, 35 feet high. Its backwater reaches 3½ miles up the river, forming a reservoir of 540 acres.

At the beginning this reservoir had an average depth of 17 feet. Many changes have taken place in these 32 years. An island has formed, occupying four-fifths of the reservoir, or about 400 acres, at an average of 3 feet above the usual water level. This island has existed long enough to be grown up with willow, elderberry, mulberry, birch, swamp dogwood, ash, red elm, maple, black walnut, sycamore, and other tree, the largest of them 20 inches in diameter.

Silt Washed Down

Only a narrow channel is left where there were once 600 acres of open water. The engineer in charge states that the flood gates have been opened regularly since 1920 in an effort to release some of the silt. This would seem to indicate that the greater part of the silt has been washed down the river. It is estimated that in about 16 years 432 acres of the reservoir have been covered with soil to an average depth of 19 feet. This is the equivalent of 1 foot of soil over 8,208 acres.

Another relic of the past. Note the gullied road, now unused.

And this is only one of the many dams along the Dan! This is, furthermore, but part of the story. It does not account for the soil deposited on the lowlands or the thousands of tons carried downstream.

Damage Runs High

I know of a 500-acre farm located about 18 miles from Danville for which the owner refused $60,000 10 years ago. Today, due to severe sheet erosion and other factors, all of the cultivated fields are denuded of their topsoil, and the farm would not bring $10,000. It is obvious that the extent of damage from soil erosion in the Piedmont section will run into millions of dollars annually.

Thousands of farmers in this section are operating on slopes stripped of the more productive surface

layer and have only the slimmest opportunity to make a satisfactory living.

Virginia is primarily agricultural and the welfare of its population, urban as well as rural, depends to a large extent upon the general prosperity of the farming people. The number of people living on farms in Virginia in 1930 was 984,746, representing nearly 40 percent of the population of the State in that year.

Hastens Erosion

The type of farming practiced by most tobacco growers accelerates the erosional process. Scrub pine and broom sedge are nature's remedies for healing and reclaiming lands so damaged.

J. C. C. Price, agricultural agent of Patrick County told me that in June 1935 during a heavy rainstorm more than six acres of topsoil slid from one of the steep slopes covering rich bottom lands in the Dan River Valley between Kibler and Bell Spur.

Ararat River has its headwaters not far from the falls of the Dan in the Southwestern part of Patrick County. The Ararat here is a comparatively clear stream, but its waters become almost brick red after joining the Yadkin River in North Carolina.

This property has seen better days. Typical of the abandoned homes of the region.

The foregoing description of stream silting due to erosion in the Dan River watershed is applicable to similar areas in the territory drained by the Mattaponi, the Rappahannock, the Pamunkey, the James, the Appomattox, the New, the Nottoway, and the Meherrin.

This great economic loss is by no means confined to Virginia, for the same conditions may be found throughout the Southeast from Pennsylvania to Florida.

If we remember that it was only 189 years ago that the first settlers came to Pittsylvania County, that most of the soil wasting has occurred in the past century, and that 40 percent of the land once in cultivation has been destroyed for farming purposes, we are led to wonder if the remaining portion will be lost to agriculture within the *next* hundred years.

Yet there is hope. The remaining soil can be kept where it is and the majority of the water can be absorbed by the soil and saved for the crop, if the proper soil and water conservation practices are followed generally in the future.

BETTER PRICES FROM CONTROLLED GRAZING

By B. W. Allred

Two cowmen neighbors, separated only by wire fences, recently placed their calves on the Denver market.

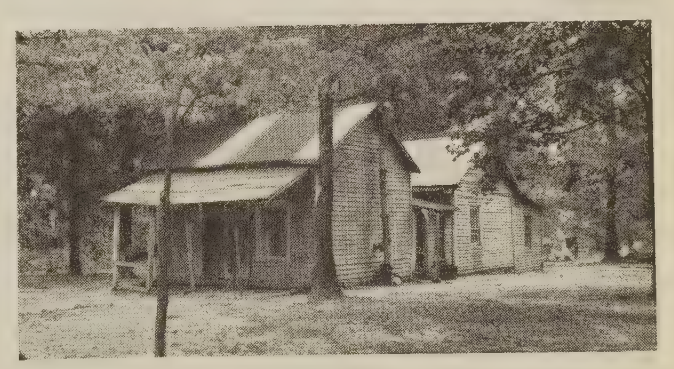
The steer calves belonging to one of them averaged 336 pounds and sold for $7.25 per hundred pounds, or $24.36 each. The heifers weighed 336 pounds each and brought $6.25 per hundred pounds, or $21 each.

The market situation in the second case is as follows: The steers weighed 440 pounds and sold for $8.10 per hundred pounds, or a gross of $35.64 per head. The heifers weighed 408 pounds and sold for $7 per hundred pounds, or $28.56 each.

Breeding Similar

Age and breeding were similar in both cases. The owner of the lighter calves attributes the difference entirely to pasture conditions, as he had been trying to carry more cattle than could be handled with greatest economy. He holds that his net receipts would be greater from fewer cattle properly grazed than from his present system.

Notwithstanding its run-down condition, this house with its numerous additions is occupied by a family of 12.



Cause: An abandoned road encouraging formation of gullies, some of which have started to cut under oak trees. A scene in the Dan River country.

Consequence: Gully caused by water from State highway and from abandoned road shown above.

A FORMULA FOR CAPACITIES OF RESERVOIRS

By G. C. Dobson[1]

In calculating the silting rate of a reservoir it is necessary to determine the original capacity, the volume of sediment deposited, and the present capacity. It is also essential that these three quantities be in harmony; i. e., they must be computed by the same method.

In all except a few cases in which accurate contour maps of the reservoir have been available, field surveys have consisted of establishing numerous ranges on which measurements of water depth and silt thickness could be made. These ranges are survey lines of known length extending from shore to shore across the reservoir, and commonly tied into a triangulation network. Lacking original maps, the shore line at spillway crest elevation has been surveyed. As a result, in the majority of cases, the computer has been faced with the problem of finding these volumes from a map of the shore line of the lake at spillway crest elevation with a set of ranges and range cross-sections indicating original and present bottoms of the lake.

Capacities of natural reservoirs are, of necessity, approximations; the more extensive and accurate the survey, the closer the approximation. The data obtained by these survey methods yield values of sufficient accuracy to meet the desired objectives.

After looking over the formulas and methods used in similar cases it was decided to work out something to fit this particular case. These efforts resulted in the following formula:

$$V=\frac{A'}{3}\left(\frac{E_1+E_2}{W_1+W_2}\right)+\frac{A}{3}\left(\frac{E_1}{W_1}+\frac{E_2}{W_2}\right)+\frac{h_3E_3+h_4E_4+}{130{,}680}$$

where:

V=Original capacity, silt volume, or present capacity in acre-feet.

A'=The quadrilateral area; i. e., the area in acre-feet of the quadrilateral formed by connecting the points of range intersection with crest contour between the two principal or most nearly parallel ranges.

A=The lake area in acre-feet.

E=The cross-section area, in square feet, of original capacity, silt volume, or present capacity cut by bounding range.

W=Width of bounding range at crest elevation in feet.

h=The perpendicular distance from the range on a tributary to the junction of the tributary with the main stream, or if this junction is outside the segment, to the point where the thalweg of the tributary intersects the downstream range.

The subscripts to E, W, and h indicate the number of the range with respect to the segment.

The formula is general and covers all cases except the special case of the segment next to the dam where the effect of the shape of the dam does not lend itself to inclusion in the formula. The application of the formula is exactly the same for original capacity, silt volume, or present capacity and all quantities used, except the quantities, E, will have the same values.

The segments, or subdivisions, of the lake may be bounded by any number of ranges and intervening stretches of shore line. Areas with two ranges may have one or two stretches of shore line and areas with three or more ranges may be closed figures with no shore line or may have any number of stretches up to the number of ranges.

For each segment, the numbers of the ranges, which are the subscripts in the formula, will generally be taken so that no. 1 is the downstream range, no. 2 the upstream, and nos. 3 and higher are ranges on tributaries or arms of the lake. In cases where the range on a tributary or arm of the lake is nearer parallel to range no. 1 than the upstream range it is taken as no. 2 and the upstream range as no. 3.

It will be seen from the derivation of the general formula, as given below, that theoretically there must be at least two ranges in a segment. Where only one appears, as on a tributary or lake arm, no. 2 must be considered as a point at the extreme upper end of the arm. Here we have a range with zero cross-section area, $E_2=0$, and zero width, $W_2=0$, but A' is not zero. The quadrilateral area, A', in this case has one side, W_2, that is zero and has the shape of a triangle with W_1, as the base and the point of hypothetical range no. 2 as its apex. In this case the formula reduces to—

$$V=\frac{A'}{3}\left(\frac{E_1}{W_1}\right)+\frac{A}{3}\left(\frac{E_1}{W_1}\right)=\frac{A'+A}{3}\left(\frac{E_1}{W_1}\right)$$

[1] The author is assistant head, Sedimentation Studies, Division of Research, Soil Conservation Service.

The use of the formula for segments having two or more ranges is obvious; the quantities bearing subscripts greater than the number of ranges are equal to to zero and vanish.

Derivation of the Formula

The problem is to find a formula that will give the most probable values for original capacity, silt volume, and present capacity when only the lake area of the subdivision, the width and cross-section areas of the ranges, and the points where the thalwegs of the streams intersect the ranges are known. Seldom were more data available in the reservoirs computed. In using the general formula, the values of the quantities h for ranges nos. 3 and higher must be known in addition to the given data. To obtain these by scaling, the points of junction of the tributaries and the main stream must be plotted from judgment, using the shape of the shore line and the points where the thalwegs intersect the ranges as guides. These values of h may not be as accurate as desired, but the problem is to find the most probable from the available data.

When an engineer wants the most accurate value of the yardage in a cut, fill, or levee from cross sections, he uses the prismoidal formula. This formula gives exact results when the figure is a true prismatoid, and for many figures that are prismoids only by liberal definition, even going so far as to apply to the case of a sphere. In the problem at hand, the figure is never a true prismoid, but the formula makes a good point of beginning.

Consider, first, an imaginary segment with two parallel ranges and shore lines that are straight lines connecting the ends of the ranges. The most probable capacity of this segment can be represented by a prismoid having either rectangles or triangles, with areas equal to the actual areas, for end faces. The width, W, and the depth, $\frac{E}{W}$ or $\frac{2E}{W}$, vary uniformly from one end face to the other. These prismoids are shown in figures 1 and 2.

Using the notation of the general formula h' for the perpendicular distance between the ranges, and the subscript m for the computed midrange, the volume of either of these prismoids can be computed as follows by the prismoidal formula:

$$V'=\frac{h'}{6}(E_1+4E_m+E_2),$$

where

$$E_m=\frac{1}{4}(W_1+W_2)\left(\frac{E_1}{W_1}+\frac{E_2}{W_2}\right)$$

which gives

$$V'=\frac{h'}{6}\left[E_1+(W_1+W_2)\left(\frac{E_1}{W_1}+\frac{E_2}{W_2}\right)+E_2\right]$$

but

$$A'=\frac{h'}{2}(W_1+W_2),$$

so that

$$V'=\frac{A'}{3}\left[\frac{E_1+W_2}{W_1+W_2}+\left(\frac{E_1}{W_1}+\frac{E_2}{W_2}\right)\right]$$

It will be seen from this equation that the average depth of this segment is $\frac{1}{3}\left[\frac{E_1+E_2}{W_1+W_2}+\left(\frac{E_1}{W_1}+\frac{E_2}{W_2}\right)\right]$. This volume can be obtained, in the case of figure 1, by breaking the prismoid down into prisms, wedges, and pyramids and taking the sum of their volumes, but in the case of figure 2, this method cannot be used because the slope faces are warped surfaces. By resorting to the calculus the volume can be proved correct in the latter case.

If the prismoid shown in figure 2 is changed to the one in figure 3, it will be bounded by eight triangular, and one quadrilateral, plane surfaces and, by the prismoidal formula, will have the same volume. That this volume is correct for the new prismoid can readily be proved by breaking it down into three pyramids.

In building up the formula so far, only straight shore lines have been considered and the area used, A', is

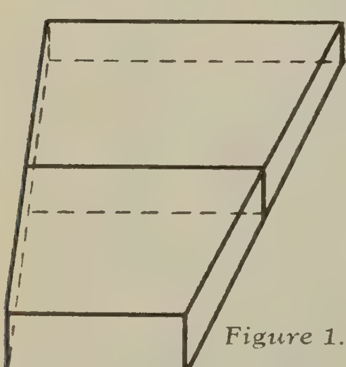


Figure 1.

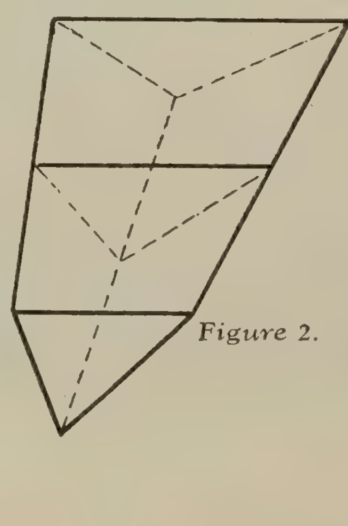


Figure 2.

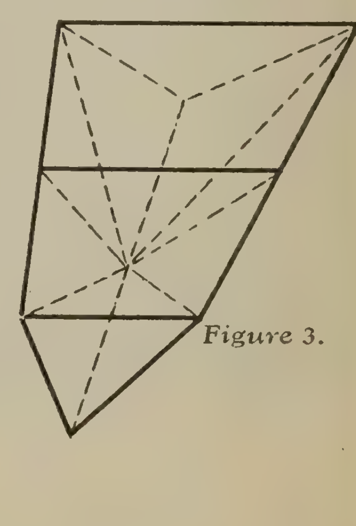


Figure 3.

the quadrilateral area of the general formula. The width of the lake is usually greater between the ranges than at the ranges. This is to be expected because the narrow places are the most practical places to locate ranges. In the large majority of cases, this makes the lake area, the, A, in the formula, greater than the quadrilateral area, A'. The total volume can be regarded as made up of the volume already established for straight shore lines, figure 3, plus the volume contributed by the excess area, $A-A'$. This latter volume might be regarded as equivalent to a wedgelike figure having the maximum depth line as its edge or a pyramid having the depth to the mid-point of the maximum depth line at its altitude. If we consider figure 3 as the most probable equivalent of the volume for straight shore line and picture the shore line as bent outward in curves the added volume takes the form of the pyramid. A study of the shape of contours in natural reservoirs provides convincing evidences that the pyramid is the form to use rather than the wedge for the excess volume. This gives for the excess volume

$$V''=\frac{1}{3}(A-A')\left(\frac{E_1}{W_1}+\frac{E_2}{W_2}\right)$$

This volume added to the volume for straight shore line gives

$$V=V'+V''=\frac{A'}{3}\left(\frac{E_1+E_2}{W_1+W_2}\right)+\frac{A}{3}\left(\frac{E_1}{W_1}+\frac{E_2}{W_2}\right)$$

From the form of this equation and from the shape of the figure developed as the equivalent of the most probable volume, it will be seen that, had it been self-evident that this was the shape to use, the above formula could have been derived by taking the sum of the volumes of three simple pyramids.

When tributaries enter the subdivision, or arms of the lake are cut off by ranges, there will be more than two ranges to consider. The formula developed for two ranges is the sum of the volumes of three pyramids with bases equal to the lake area and the two end areas. The altitude of the latter two are automatically cared for in the quadrilateral area, A'. The third and higher numbered ranges will also enter as pyramids with the range areas as bases and altitude to be determined. Bearing in mind that the shape used in obtaining the most probable volume was an equivalent shape and not the actual shape, a study of natural conditions indicate that the altitude should be the perpendicular distance from the range to the junction of the streams if the junction is inside the subdivision or, if not, to the point where the thalweg of the tributary intersects the lower range.

All the foregoing assumes that ranges nos. 1 and 2 are parallel, a condition seldom encountered in practice. The only part of the formula affected by diverging ranges is the expression involving A' as a direct factor. The computation of the error caused by this condition for any segment is impractical because it involves the unknown location of the intersection of the thalweg with an imaginary mid-range. Careful investigation of it indicates that this error is insignificant up to 10° divergence of ranges and that it tends to compensate in the sum of the volumes of the segments.

SUMMARY

The formula described in this article was developed specifically for computing original and present capacity and silt volumes in storage reservoirs. Surveys of silting in representative reservoirs throughout the United States are being carried on as part of the research program of the Soil Conservation Service through the Section of Sedimentation and Hydraulic Studies. The objective of these studies is measurement of depletion of water-storage resources of the country as a result of silting and to correlate silting rates with climate, soils, slope, and land use in the tributary watersheds. Through January 1936 detailed surveys of 26 reservoirs have been completed. In most of these, adequate, original maps of the reservoir basin were lacking, and the survey methods available at reasonable cost consisted of accurate soundings, silt thickness measurements, and crest-line contour maps. The above formula uses the data thus obtained to derive volumes with the maximum of accuracy which such data allow.

Fifty million acres, once cultivated in the United States no longer produce crops.

Three billion tons of soil are washed and blown from our fields annually.

Four hundred million dollars is lost to farmers in soil fertility annually.

SINKHOLE TERRACE OUTLETS IN MINNESOTA

By Loyal Van Doren

Sinkholes of many sizes and shapes are scattered liberally over portions of the Deer-Bear Creek area in Minnesota. A network of underground waterways undermines parts of this section, which has a peculiar limestone formation. The sinkhole, as the name implies, is formed by the sinking of a small area of land which has been undermined. The hole grows larger by surface erosion, which washes down the sides and by further sinking of the bottom due to the action of the water on the underground channels.

Sinkholes vary from 20 to 150 feet in width and from 8 to 35 feet in depth. They are, as a rule, shaped like funnels and sometimes have openings into underground caverns, limestone caves and waterways large enough for a man to enter.

Some farms in this part of the area may have one or two sinkholes which do little damage, but there are other places where as many as 20 such holes have been found, eating up as much as 5 acres out of a 40-acre tract.

Terracing for Erosion Control

Terracing is a suitable and practicable means of controlling erosion on many of the large cultivated fields here, but the cost of terrace outlets is sometimes prohibitive. Quite often these sinkholes can be conveniently used to dispose of the water from terraces, since they occur at random over the fields—on hilltops, on hillsides, or in waterways.

The bottoms of the sinkholes are unstable; therefore, the best way to dump any appreciable amount of water into the hole is to drop it directly over the center. The water is brought as far as possible with a permanent sod or masonry flume and then carried the rest of the way in a creosoted lumber flume or corrugated culvert. The latter is preferable because it is more durable.

Creosoted lumber flume used to drop water into sinkhole. This flume has masonry head and cut-off wall.

The growth of another sinkhole stopped by a diversion dike. This dike has a creosoted lumber core wall 32 feet long and 8 feet deep to prevent damage by woodchucks and gophers.

How Flumes Are Built

When creosoted lumber is used (as in the illustration) the flume is double-planked and the upper end is set into a masonry head wall. The middle is supported by creosoted posts and masonry footings. The lower end is held up by posts and footings placed back from the center of the hole on a solid foundation or by beams carried across to footings on the opposite bank. The flumes are usually made in two sections, supported independently of each other. The upper section drops the water into the lower section, but is not in any way attached to it. This is because sinkholes are treacherous. The bottom may sink farther or spread more than is expected, and if the lower section settles or fails, it will not, when constructed this way, take with it the part which is set into the head wall.

Considerable damage is often done to valuable farm land by large gullies which eat back from sinkholes—especially when they are in waterways. The general practice of the farmers in this area is to keep the banks of the sinkholes covered with vegetation. The large gullies which cannot be controlled by vegetation can be controlled by the use of diversion ditches or dikes around the gully which empty into the sinkholes in the manner just described.

REGRASSING THE SEMIARID PLAINS

By C. R. Enlow [1]

Many species of native grasses are of potential value for reseeding the depleted areas of the Great Plains and some of the more important grass seeds can be harvested from present stands. While it seems proper to favor in general the use of grasses in the areas where they are indigenous, experience teaches the disadvantage of restricting seeding to the established boundaries. Buffalo grass is a notable example of a grass indigenous to the Great Plains which has been growing for years in Washington, D. C., in Vermont, and in California. For the time being, however, our recommendations for seeding are based on the area naturally occupied by the grass.

Undoubtedly, the grass that presents the best possibility for harvesting and use in reseeding is *Agropyron smithii* (western wheat grass of the Great Plains and bluestem of the intermountain region). The grass is found in practically every State west of the Mississippi River and, to a lesser extent, east of the Mississippi. It is a fine native hay, and grows in almost pure stands from Montana to Arizona and New Mexico. Thousands of acres of fine stands are found in Nebraska and southern South Dakota, and in this section the Soil Conservation Service harvested nearly half a million pounds of seed for use on western projects. The grass grows like wheat and can be harvested with a combine, but naturally the land must be removed from grazing or haymaking and held for seed production. The seed is fairly large, which adds to its desirability for seeding on land with limited rainfall. *A. smithii* has underground stems, and spreads by this method, but is not a pest like its near relative *Agropyron repens*, the troublesome quackgrass. Farmers and seedsmen of Nebraska say that the grass-seed crop of 1934 was the best in 20 years.

Valuable for Grazing

Agropyron spicatum (bluebunch wheatgrass) is a good grass native from Washington to northern California, and east as far as Colorado. It was one of the valuable grazing grasses of the Palouse wheat country of eastern Oregon and Washington before that land was put to the plow and is still found in excellent stands in many places throughout the semi-dry areas of the Northwest.

Several thousand pounds were collected during the past season for planting on erosion-control projects in the Northwest. Where the land is sufficiently smooth this grass can be harvested with a combine, header or stripper. *Festuca Idahoensis* (bluebunch fescue) is another desirable grass in the dry lands of the Northwest that can be harvested and handled similarly to this one.

Andropogon scoparius (little bluestem) and *Andropogon furcatus* (big bluestem) occur practically everywhere in the country except the far West, and are especially valuable in the Flint Hill region of Kansas. These are the principal grasses of that fine grazing country, used for many years to fatten Texas and Oklahoma cattle for the Kansas City market. Their worth is recognized all through the eastern Great Plains, but only recently has the possibility of reseeding been explored. Ours was the first large-scale harvesting of seed. We found that ordinary farm machinery can be used toward this end, but difficulties are met in the threshing as the seed is awned and fuzzy or hairy. The bulk of the seed was harvested with power strippers, thus avoiding the necessity of threshing. Curiously enough, the bluestems, where they are found growing in the Eastern States, including New England, are practically worthless for hay or grazing.

Important in Dust Bowl

Buchloë dactyloides (buffalo grass) is one of the most interesting and desirable grasses as it formerly occupied much of the land from which the dust storms originated last year. It has always been highly regarded for grazing. It retains its palatability and nutritive value during the winter months after it has become brown and dry.

Buffalo grass occurs all through the low rainfall belt from Montana and North Dakota to Texas, although it is not abundant north of Nebraska. It is at its best in western Kansas and eastern Colorado. It seldom grows more than 3 or 4 inches tall, and has both male and female plants. The male flowers rise above the grass, appearing as ordinary seedheads and the female flowers occur near the ground where the seed is formed. Frequently, quite large patches of exclusively one type are found, perhaps originating from a

[1] The author of this article is in charge of the agronomy section, Soil Conservation Service.

single plant. Our attempts to harvest the seed have been discussed in other articles.

Buffalo grass has been reestablished successfully by scattering small pieces of sod at intervals of several feet. It spreads very rapidly by prostrate runners which readily take root when sufficient moisture is present. This method is thought too expensive, however, for extensive use.

Reseeds Readily

Bouteloua gracilis (blue grama) is a companion to buffalo and is often confused with it. It extends farther north and is found in abundance in North Dakota and Montana. Blue grama presents a much better possibility for reseeding than does buffalo, as the seed can be gathered with bluegrass strippers. Although yields are low, 80,000 pounds of seed have been collected for use on wind erosion control projects by bluegrass strippers and an ingeniously devised power stripper which will cover 35 acres per day. Omitting the western wheatgrass, the major portion of the seed of all species has been collected with the power strippers. Other gramas that are of value but scarcely as promising as blue grama, are *Bouteloua eripoda* (black grama) which occurs in western Texas and New Mexico; *Bouteloua curtipendula* (side oats grama), which is widely distributed but grows in somewhat scattered areas, thus presenting difficulties in harvesting; and *Bouteloua hirsuta* (hairy grama), which is found with buffalo grass and blue grama, but generally is not so aggressive nor so abundant as either.

Harvested by Ordinary Machinery

Sporobolus wrightii (sacaton) is an excellent grass for reseeding in dry regions of Arizona and New Mexico, and can be harvested with ordinary farm machinery. It is very desirable hay in that section. *Sporobolus airoides* (alkali sacaton) is a widely distributed related species that is also desirable for reseeding. A very large quantity of seed of these grasses is desired, and a considerable quantity has been harvested. *Sporobolus cryptandrus* and *Sporobolus asper* are two other species of the genus commonly called "dropseed" that are widespread in the West and offer possibilities in range reseeding work. A fair quantity of seed has been collected for trial plantings.

Oryzopsis hymenoides (mountain rice or Indian ricegrass) is excellent for dry land, and is found throughout the length of the Great Plains and west to the Pacific coast. It presents commercial possibilities, but occurs generally in scattered stands. The seed can readily be harvested with ordinary machinery, but presents a difficult germination problem.

Good for Hay

Sorghastrum nutans (Indian grass) is a very good hay and grazing grass that occurs in mixture with the bluestems, and is a particularly valuable constituent of bluestem pastures and meadows of the eastern Great Plains from the Dakotas to Texas. In harvesting bluestem seed, some mixture with Indian grass seed is almost a certainty, and desirable, as mixtures usually give a longer grazing period or greater yields of hay. Indian grass seed has long twisted awns or beards, and is fuzzy, placing it in the class of seeds that are naturally difficult to thresh, clean, and sow with machinery.

Stipa comata (needle thread) is a rather common grass that occurs in semidry areas throughout the West, and is an important grazing plant. *Stipa spartea* (porcupine grass), a near relative, is found in the Dakotas and Nebraska and east, under more humid conditions. Both are good grazing grasses. Their seed has been gathered with strippers. The collecting season is short, however, as the seed soon falls to the ground after ripening. Frequently, when the *Stipas* (often called needlegrasses as a group) are found in native meadows, haying is delayed until the seed falls to the ground as the long twisted awns and sharp-pointed seed are very undesirable in hay and sometimes cause injury to livestock. Nature has arranged for this grass to plant its own seed, and it is possible when the dew is drying from the rays of the morning sun, to watch the awns twist and untwist each movement causing the sharp-pointed seed to burrow further into the soil, until finally the awns break and blow away. While there are more desirable grasses, the needlegrasses should not be neglected in the attempt to improve the vegetative cover of the western range.

Adapted to Dry Plains

Hilaria jamesii (galleta) is a very valuable grass of the deserts and dry plains of the Southwest. The genus *Hilaria* has very few species, but *Hilaria jamesii*, in company with *Hilaria mutica* (tobosa) and *Hilaria belangeri* (curly mesquite) play a very important part in supplying grazing for livestock in the dry lands from western Texas to southern California. Seed can be gathered by machinery, and

where good areas of these grasses can be found, strippers can be used if the terrain is sufficiently level to allow the use of machinery. Curly mesquite is similar in appearance to buffalo grass, and is often confused with it.

Koleria cristata (junegrass) is an important constituent of the flora of our western ranges. It has a wide adaptation, being found from New England to California and south to Texas, although it does not occur in our Southeastern States. Generally it occurs in mixture with other grasses, and is a desirable addition. The seed matures quite early but does not shatter badly, and can be readily stripped.

Also Show Promise

It is impossible to mention here all the grasses that are possibilities in the erosion control program, but such grasses as *Redfieldia flexuosa* (blowout grass) and *Calamovilfa longifolia* show promise for the sand dunes of Nebraska, Kansas, and adjoining territory: *Ammophila breviligulata* (American beachgrass) for the coastal sands of the West and the Northwest, as well as for the Great Lakes; and *Puccinellia nuttalliana* (nuttall alkali-grass) and *Distichlis stricta* (desert saltgrass) for the alkali lands from Washington and Montana to Colorado.

In this discussion of our native grasses adapted to dry-land use, not commercially available on the market, it is scarcely fair to omit the few grasses that are available in more or less limited quantity, merely because three out of the four so used are not native. *Agropyron cristatum* (crested wheatgrass) is ideal for all the northern country, but it has not been grown successfully south of northern Kansas, and the seed is very high in price due to the limited quantity available. *Bromus inermis* (smooth bromegrass) and our native *Agropyron pauciflorum* (slender wheatgrass) are also confined to the Northern States due to their inability to live through the summer weather from Kansas south to Texas. The last three are the best commercially available grasses for seeding in regions of low rainfall from North Dakota to Nebraska and west. At high elevation they can be seeded farther south.

Poa bulbosa (bulbous bluegrass) has been growing successfully for several years in Oregon and Washington and northern California and undoubtedly has real possibilities in the dry lands of southern California, Arizona, and New Mexico, as on a recent plant exploration trip to Turkey it was found growing everywhere in the interior deserts, and almost to the shores of the Mediterranean within a few miles of citrus and palm trees. *Poa bulbosa* is adapted to regions of winter rainfall. The grass emerges in the fall, remains green all winter, and matures a seed crop in May and June, after which the tops die, but the bulbs remain alive in the soil, ready to send up shoots at the first fall rain.

Outlook Promising

The outlook for commercial seed production of our native grasses is most promising. Many trial plantings have been made the past 2 years and excellent seed crops have been harvested. Blue grama planted in rows at San Antonio, Tex., last spring gave two good seed crops during the summer. The bluestems, Indian grass, range mesquite, switchgrass, western wheat, and many others have shown their ability to produce excellent crops of seed the same season as seeded. It seems apparent the production of grass seed adapted to our semiarid regions offers a real source of income for farmers who are interested in this line of work.

The Soil Conservation Service is making a determined effort to meet the need for immediately covering a portion of the dry regions of the West with permanent sod, through the use of native grasses now found in the various regions and by working on a large scale hopes to sell the idea to the farmers, who may harvest the seed as a source of income and thus advance the erosion-control program in a few years far beyond what the Soil Conservation Service might accomplish by itself in a generation, as, after all, the solution to erosion in the western country must be through the use of vegetation.

One hundred and twenty-five million acres in the United States have lost their best topsoil.

Bluegrass sod, experiments at the Missouri Experiment Station show, holds back 137 times as much soil on a 3.7 percent slope of Shelby silt loam as bare ground. This rate of erosion points to the removal of a 7-inch soil layer in 24 years from bare ground and 3,547 years from sod.

MOISTURE MEASUREMENTS POINT WAY TO WIND-EROSION CONTROL

By O. T. Williams

When hunters first came to the high plains country, they found little evidence of wind erosion. The only damage was along stream beds where the action of water and wind had prevented nature from establishing covering. The rest of the land was protected by vegetation.

Only in the last few years has wind erosion in this area become a problem. This is due to the great expansion of agriculture, the growing of crops not resistant to erosion and the improper management of crop residue. There were periods of low rainfall before this land was placed in cultivation, but the vegetative cover held the soil and harbored the moisture until the rains began again.

It has been demonstrated on the Dalhart, Tex., project that wind damage can be controlled by use of erosion-resistant crops and the wise management of crop residues. Since water is an important factor in the production of these crops, it is necessary to make use of all that is available. This can be done in different ways. Important methods are: (1) Addition of organic matter; (2) proper tillage methods, and (3) control of run-off water. The latter is the leading factor in this area.

H. H. Finnell ran an experiment at Goodwell, Okla., on heavy silt loam planted to milo, which proves the value of a water-conservation program. He had three plots on unterraced land. No effort was made to control run-off water. Each plot was planted to a different variety of milo. A record of the total pounds of dry matter was made for each plot. The following was produced: Plot 1, 2,239 pounds; plot 2, 2,276 pounds; and plot 3, 2,426 pounds. The average was 2,313.6 pounds. These were produced with 17.3 inches average annual rainfall.

Records were kept to determine what became of the rainfall and the percentage which is available for crop production. Of the 17.3 inches of rainfall, it was found that 5.3 inches came in small rains that were ineffective for crop use. Out of the 12 inches which got as far as the subsoil, 2.2 inches ran off to the flat lakes. Of the remaining 9.8 inches, 6.05 inches were lost through natural evaporation or evaporation caused by tillage. Only 3.75 inches of water was available for plant growth.

One acre-inch of water weighs 226,270 pounds. The available water on each plot was 848,512.5 pounds.

Since the average production of dry matter on the plots was 2,313.6 pounds and 848,512.5 pounds of water was available, it was assumed that 366 pounds

(Continued on next page)

CONTOUR LISTING SAVES SOIL AND MOISTURE

The effectiveness of contour ridges in conserving moisture is shown by measurements taken at the Panhandle Agricultural Experiment Station at Goodwell, Okla., on May 17–18, 1935, when 1.79 inches of rain on land not listed on the contour penetrated only 8.75 inches, while the penetration on contour-listed land was 20.33 inches.

Terraces doubled the depth of penetration, yet contour ridges without terraces conserved more water than terraces without contour ridges. The terraced land had a penetration of 16.04 inches. Land terraced and ridged on the contour had the greatest penetration, 21.69 inches.

Disking was found to increase the penetration very little, less than one-half inch in this experiment. Contour chiseling caused an increase in penetration of 5.49 inches.

Erosion was less on contour-ridged land than on any other. All run-off water moved slowly, reducing to a minimum the wastage of soil.

Growing cultivated crops on the contour has advantages like those of contour ridging wheat land. The row ridges hold the rainfall where it can be utilized for plant production rather than permitting it to run off the fields rapidly, carrying away large quantities of soil.

MOISTURE MEASUREMENTS

(Continued from preceding page)

of water were required to produce 1 pound of dry matter.

Other experiments by Briggs and Shantz in Colorado show that 1 pound of dry matter of milo can be produced from 331 pounds of water. These experiments were made under laboratory-controlled conditions, while the work done by Finnell was under field conditions.

Effect of Terracing

Another series of experiments by Finnell shows that less evaporation occurs on terraced land than on unterraced. He found that the percentage of evaporation on unterraced land was 68.8 percent and on terraced land was 65.5 percent.

If the 2.2 inches which ran off the milo plots had been controlled by terraces and contour tillage, 0.759 of an inch more moisture would have been available for the production of milo. This would have added 172,870.28 pounds of water to each plot. Assuming that 1 pound more dry matter would have been produced by each 366 pounds of added water, the increase in production of dry matter would have been 472 pounds. This would have increased the average to 2,785.6 pounds, an increase of 20.4 percent. These yields were in pounds of total dry matter, including both grain and forage. Yields of wheat grain were increased 34 percent by saving the run-off water. The proportion of grain to straw increased as the number of successful crops increased. The close check between the water utilization by milo under controlled conditions and under field conditions indicate a high productive efficiency for the plains area.

In summary, it may be said that the use of agronomic practices which contribute to the amount and continuity of vegetative covering will aid in controlling wind erosion. The conservation of run-off water aids in controlling wind erosion and also increases the immediate profits of the farmer.

The South African Farmer reports that in the year ended August 1935, 5,500 applications for assistance had been received by the South African Department of Agriculture, which is making an effort to control soil erosion.

Erosion has caused streams to dry up, resulting in the disappearance of fish, animal and bird life.

A NEW JERSEY CONVERT TO TERRACING

The continual gullying of his fields and sedimentation of his meadow made Fred H. Totten of the Raritan-Neshanic River area welcome the coming of the Soil Conversation Service to New Jersey in the spring of 1935. He became the first farmer in the State to sign a cooperative agreement.

It was when his gullies were being filled preparatory to terracing that Mr. Totten declared that he had hauled more than a thousand loads of dirt back onto the field in the 15 years he had been on the place.

"Heavy rains have always washed gullies there," he said. "I know I have lost a lot more soil than I have hauled back. I only loaded up some that landed on the meadow below and used it to fill in the worst washed places. It was back work, not brain work. I couldn't keep the dirt on the hillside after I put it there."

Mr. Totten expects the new terraces, together with other conservation practices, to protect his farm successfully in the future.

The other day as he stood on his terraced field, he said:

"The fellow who farmed this place before me was here a while back. He is an old-timer and doesn't think much of some of the new ways of doing things, but he was interested in looking over this terracing. He said it would be a good thing if it stops the washing, for he did his full share of hauling, too."

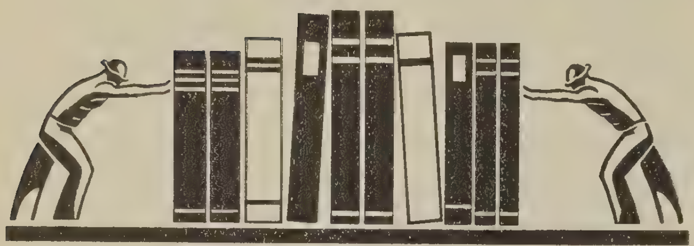
Fred H. Totten, first to sign cooperative agreement in New Jersey, with Harry Holcombe, of Soil Conservation Service.

More than 300,000,000 tons of rich soil are dumped from the fields of the Mississippi Valley into the Gulf of Mexico each year.

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

A contribution from the Soil Conservation Service Library



RANGE AND PASTURE MANAGEMENT. By Arthur W. Sampson, M. A., Ph. D. 1923.

Reviewer's Note.—This book, although not of recent publication, is os such current and fundamental importance to many of our workers that a review if regarded as being worth while at this time.

Grazing lands and the livestock industry, the judicious utilization and management of public and private lands upon which the future of the industry depends, is an economic problem of tremendous importance. Dr. Sampson's book provides systematic instruction for those who desire a practical working knowledge of the subject, as well as for those who wish to follow technical grazing management and improvement as a profession.

Opening with a reconnaissance of pasture sections in the United States, their native grasses and forage plants, their water availability, and methods used in the past for their improvement and protection, the author prepares the student for the substance of the book—practical instruction in new and scientific methods for correcting overgrazed pastures and timberlands and the declining forage yield.

Reseeding on western grazing lands is treated in detail, as well as plant introduction on arid lands, on mountains, and in semihumid sections. From mountain reseeding tests conducted in every State west of the Texas and Dakota line, with plots located where need for forage was greatest and on elevations ranging from 4,000 to 11,000 feet, by far the best results were obtained with timothy, 64.4 percent of all trials being successful or partially so. Next in order of successful results were Hungarian bromegrass with 58.14 percent, perennial ryegrass with 50 percent, Italian ryegrass with 37.5 percent, Kentucky bluegrass 31.82 percent, and red top with 33.33 percent.

Other phases of the subject which are given exhaustive treatment are: Methods of preparing and reseeding burned-over lands; how to graze newly seeded pastures; revegetation by deferred or rotation grazing; grasses and broad-leaved herbs for restoration; plant indicators for recognizing and correcting worn-out lands; principal introduced forage grasses and nongrasslike forage herbs. A useful plant-indicator list is arranged according to the natural grass or weed stage, first or early weed stage with Douglas knotwood (*Polygonum douglasii*) topping the list, second or late weed stage with blue foxglove (*Penstemon procerus*) leading, mixed grass and weed stage with small mountain porcupine grass and yellowbrush conspicuous, and the climax herbaceous stage when the wheatgrasses are predominant.

For the control of erosion on range and pasture lands, Dr. Sampson suggests cover plants, especially on hillsides, as the safest possible insurance against erosion and consequent damage. He urges the avoidance of overgrazing, or too early grazing, control and distribution of livestock, terracing and planting, and the construction of dams.

A chapter on the burning over of pasture lands emphasizes the danger of such practice, not only from the standpoint of engendering wide-sweeping and devasting fires but because of its destructive effects on forage production through impoverishment of the soils.

In the book are comprehensive chapters on stock-poisoning plants and their control. Important families of such plants are listed, described, and discussed as to methods of eradication. Among poisonous plants described and illustrated are the toxic milkweeds, the Gambel oak (*Quercus gambelii*) and shinnery oak (*Q. harvardi*), laurels, woody aster, aconite, ergot (a parasitic fungus), and the downy, hairy, and red bromegrasses whose sharp awns at seed maturity penetrate and cause sores and inflammation of skin, eyes, mouth, throat, stomach, and intestines of grazing animals.

In part 4 those interested in the technical management of pastures will find improvement research methods clearly outlined; also, complete directions for making a grazing reconnaissance. The "forage acre" formula is given, discussed, and explained. Research methods in revegetation, including plot procedure, are described and designated, and there are many tables, drawings, and illustrations for clarification of the subject.

At the close of the book is a 26-page condensed outline for practical and professional instruction in pasture and livestock management. Important features are the bibliographies at the ends of all chapters; grazing tables according to States, years, and increase; numerous illustrations from originals; and, in table form, the plan for revegetation by deferred and rotation grazing. The book includes a complete index to all references and subject matter.

Owing to the fact that the library has but one copy of this book, only short-period loans can be extended.

FORESTRY AND SCHOOL STUDIES, A CORRELATION FOR ELEMENTARY SCHOOLS. By E. V. Jotter. January 4, 1933.

Presents various phases of forestry in such a way that the subject may be introduced into the curriculum by correlation with arithmetic, reading, language, drawing, geography, history, and nature study. A study of trees and forest products; forest-fire control; conservation; insects, fungi, and other tree enemies; forests, water, and soil; national forests; starting a community forest. Includes teaching references and notes on 35 forestry publications. The appendix contains a plan for improving rural school grounds, with references, and the Municipal or Community Forest Act 217 of the Public Acts, 1931, of the State of Michigan.

PLANT PROPAGATION. By Alfred Carl Hottes. 1934.

This is a handbook for the plant propagator. In it are to be found the answers to 999 questions on the production of plants. There is much useful information on such subjects as plant breeding, seeds, cuttings, bulbs, grafting, fruit stocks, annuals, ferns, orchids, roses, tree shrubs and woody climbers, conifers, and evergreens. 265 illustrations. Index to plant names and general index.

SOME DEPARTMENTAL PUBLICATIONS OF VALUE TO SOIL CONSERVATION WORKERS

Field offices of the Service should address all requests for publications to E. G. Rogers, Publications, Soil Conservation Service, 214 Courts Building, Washington, D. C. Others should address requests to the Office of Information, U. S. Department of Agriculture, Washington, D. C.

Circulars

Forests and Floods. Ward Shepard. Forest Service. Issued January 1928. Revised May 1931. Circular No. 19.

Soil Erosion A National Menace. H. H. Bennett and W. R. Chapline. Bureau of Chemistry and Soils. April, 1928. Circular No. 33.

Artificial Reseeding on Western Mountain Range Lands. C. L. Forsling and William A. Dayton. Forest Service. August 1931. Circular No. 178.

Effect of Cover on Surface Run-off and Erosion in the Loessial Uplands of Mississippi. H. G. Meginnis. Forest Service. June 1935. Circular No. 347.

Leaflets

Controlling Small Gullies by Bluegrass Sod. R. E. Uhland. Bureau of Chemistry and Soils. December 1931. Leaflet No. 82.

Strip Cropping to Prevent Erosion. H. V. Geib. Bureau of Chemistry and Soils. Issued November 1931. Leaflet No. 85.

Miscellaneous Publications

Reconnaissance Erosion Survey of the Brazos River Watershed, Texas. H. V. Geib and Ira T. Goddard. February 1934. Miscellaneous Publication No. 186.

Floods and Accelerated Erosion in Northern Utah. Reed W. Bailey, C. L. Forsling, and R. J. Becraft. August 1934. Miscellaneous Publication No. 196.

Soil Blowing and Dust Storms. Charles E. Kellogg. Bureau of Chemistry and Soils. March 1935. Miscellaneous Publication No. 221.

Technical Bulletins

Properties of Soils Which Influence Soil Erosion. H. E. Middleton. Bureau of Chemistry and Soils. March 1930. Technical Bulletin No. 178.

Erosion and Silting of Dredged Drainage Ditches. C. E. Ramser. Bureau of Public Roads. June 1930. Technical Bulletin No. 184.

A Study of the Influence of Herbaceous Plant Cover on Surface Run-off and Soil Erosion in Relation to Grazing on the Wasatch Plateau in Utah. C. L. Forsling. Forest Service. March 1931. Technical Bulletin No. 220.

A Laboratory Study of the Field Percolation Rates of Soils. C. S. Slater and H. G. Byers. Bureau of Chemistry and Soils. January 1931. Technical Bulletin No. 232.

Physical and Chemical Characteristics of the Soils from the Erosion Experiment Stations. H. E. Middleton, C. L. Slater, and Horace G. Byers. Chemistry and Soils. June 1932. Technical Bulletin No. 316.

Farmers' Bulletins

Some Common Birds Useful to the Farmer. F. E. L. Beal. Bureau of Biological Survey. Issued February 1915; revised April 1926. Farmers' Bulletin No. 630.

Principles of the Liming of Soils. Edmund C. Shorey. Bureau of Chemistry and Soils. Issued 1918; revised April 1930. Farmers' Bulletin No. 921.

Gullies: How to Control and Reclaim Them. C. E. Ramser. Bureau of Agricultural Engineering. Issued February 1922; revised January 1935. Farmers' Bulletin No. 1234.

Important Cultivated Grasses. C. V. Piper. Bureau of Plant Industry. Issued February 1922. Last revision July 1934. Farmers' Bulletin No. 1254.

Soil Productivity as Affected by Crop Rotation. Wilbert W. Weir. Bureau of Soils. May 1926. Farmers' Bulletin No. 1475.

Growing Black Locust Trees. Wilbur R. Mattoon. Forest Service. May 1930. Farmers' Bulletin No. 1628.

Farm Terracing. C. E. Ramser. Bureau of Agricultural Engineering. Issued July 1931; slightly revised March 1935. Farmers' Bulletin No. 1669.

Using Soil-Binding Plants to Reclaim Gullies in the South. H. G. Meginnis. Forest Service. January 1933. Farmers' Bulletin No. 1697.

Improving the Farm Environment for Wild Life. Wallace B. Grange. Bureau of Biological Survey. January 1934. Farmers' Bulletin No. 1719.

Stop Gullies: Save your Farm. Wilbur R. Mattoon. Forest Service. September 1934. Farmers' Bulletin No. 1737.

Summer Crops for Green Manure and Soil Improvement. Roland McKee. Bureau of Plant Industry. September 1935. Farmers' Bulletin No. 1750.

Yearbook Separates

Soil Erosion Problem Under Investigation in National Control Program. H. H. Bennett. Reprint of pp. 349–351, Yearbook of Agriculture, 1932. Separate No. 1274.

Terraces Effective for Controlling Erosion on Cultivated Land. C. E. Ramser. Reprint of pp. 346–348 of Yearbook of Agriculture, 1934. Separate No. 1418.

Soil Erosion Studies Show Vegetation Has Dominant Role. H. H. Bennett. Reprint of pp. 322–327 of Yearbook of Agriculture, 1934. Separate No. 1451.

Soil Erosion Studies Develop Information of High Practical Value. R. V. Allison. Reprint of pp. 299–305, Yearbook of Agriculture, 1935. Separate No. 1542.

U. S. GOVERNMENT PRINTING OFFICE: 1936

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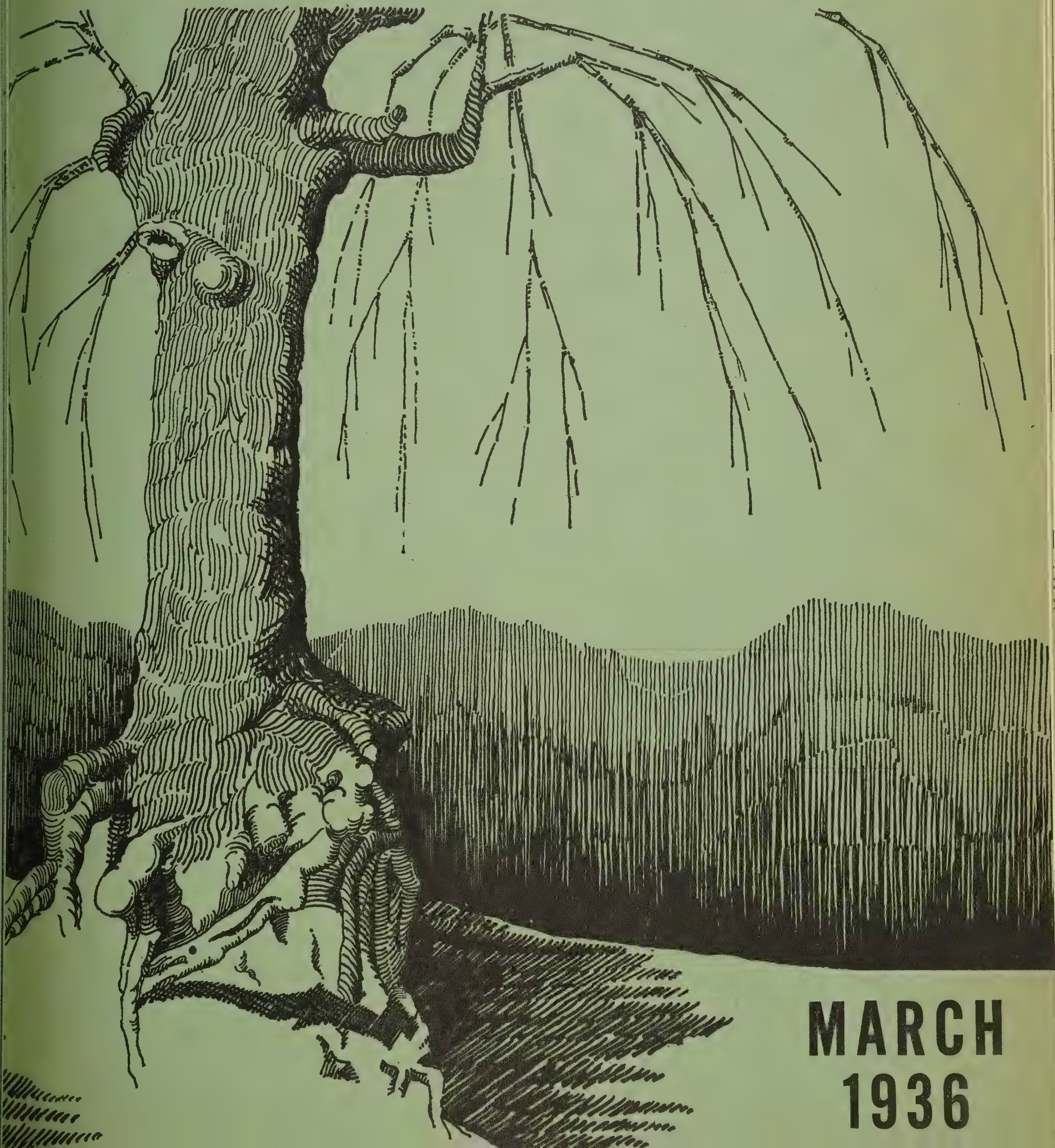

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SOIL CONSERVATION is issued monthly by SOIL CONSERVATION SERVICE of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. SOIL CONSERVATION seeks to supply to workers and cooperators of the Department of Agriculture engaged in soil conservation activities, information of especial help to them in the performance of their duties, and is issued to them free by law. Others may obtain copies from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic. Postage stamps will not be accepted in payment.

WELLINGTON BRINK — EDITOR

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

H. H. BENNETT
Chief, Soil Conservation Service

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SOME ABC'S OF SOIL CONSERVATION

By E. J. Utz[1]

All programs and policies in soil conservation are based on certain applicable criteria. These criteria are the result of careful study and experimentation under a great variety of conditions. The effectiveness of the resulting program depends largely on the accuracy with which these criteria have been worked out, and their proper application to the problems involved.

The principal factors to be considered in the control of soil erosion are slope, soil type, degree of erosion, and land cover. The latter two are the result of man's use or misuse of the land. The first two are not under man's control, and consequently are of basic importance in determining the land use and the erosion control practices that are to be put into effect on any given parcel of land.

Slopes Determine Erosion

Certain slopes on a given soil type are suitable for one purpose while the same slope on a different soil type cannot be used in the same way without serious losses. It was necessary, therefore, to determine what slope limits should be used for the growing of clean-tilled crops, what limits should be used only for close-growing crops, and what limits must be retired from cultivation in order to prevent serious soil and water losses, for each of the principal soil types. Thus, a knowledge of the soil type and degree of slope is of primary importance in determining the land use and the soil-conservation practices that are to be put into effect.

If soils are to be surveyed and mapped, essential information should be listed in the most usable manner, so that those carrying out the program in the field can translate it directly into land use and control methods. As a result of this viewpoint, the Soil Conservation Service set up four slope classes: A, B, C, and D. Land mapped as A slope generally requires no particular erosion-control measures other than proper rotation of crops; B slope requires particular erosion-control measures when clean-tilled crops are to be included in the rotation; C slope should be in close-growing crops, especially pasture and hay crops, and is not generally suitable for clean-tilled crops; and D slope should be retired to forest or pasture, depending on the original vegetation.

Slope Variations

Due to the variations in soil types, rainfall, climate, and other factors in the different areas, the slope limits for the different classes vary considerably. For example, in the Piedmont section of the South, the A slope varies from 0 to 2 or 3 percent, while in other sections it may run as high as 0 to 5 percent. B slopes in the Piedmont usually run 3 to 8 or 10 percent, while in other sections the upper limits may go as high as 20 or 25 percent.

[1] The author is principal soil conservationist, in charge of the Section of Erosion Control Practices.

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Much of the steep land in the United States is cultivated in regular rotation, and in many sections is devoted year after year to clean-tilled crops, until the top soil has all been washed away. The resultant deposition is now silting up streams and storage reservoirs, and adding to the flood hazards of the Nation. This damage occurs in addition to the loss resulting from the depletion of the agricultural resources of the country, and the impoverishment of the farm operators and owners.

Since slope is such an important factor in the erosibility of soils, it is given primary consideration in the determination of proper land use. On the various demonstrational areas, every effort is being made to induce farmers to retire the steeper slopes to grasses, shrubs, and trees. This type of vegetation has been found to be the most erosion resistant of the crops commonly grown.

In checking over the farm plans developed on the various project areas, and in considering the acreage of clean tilled crops that are now grown on the steeper slopes as compared with those grown on the same slopes previous to the inception of the soil-conservation program, we find conclusive evidence to demonstrate that a good land-use program has been put into effect. Table 1 shows the acreage of cotton grown on the various slopes before the soil-conservation program was initiated, and the corresponding acreage grown under the conservation plan, on 16 projects in the Cotton Belt. These projects are located in the States of Alabama, Arkansas, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, and Texas.

It will be noted that almost two-thirds of the reduction in acreage was made on the C and D slopes, where 12 percent of the cotton was originally grown. Less than 7 percent of the cotton on these areas is now grown on slopes steeper than those generally recommended for this crop. Individual farm conditions sometimes make it impossible to apply uniformly any rule that may be developed. Also, there are certain soil types that are less erosible than others, and allow for a deviation from the generally accepted practices.

The total reduction in cotton acreage on these 16 projects was 9.1 percent. The reduction on the A

(Continued on page 3)

TABLE 1.—*Cotton acreage estimates for 16 projects*

	A slope		B slope		C slope		D slope		Total	
	Acres	Percent of total crop	Acres	Percent of total crop	Acres	Percent of total crop	Acres	Percent of total crop	Acres	Percent total reduction, all slopes
Before erosion-control program	28,144.0	16.9	118,410.0	71.1	16,037.7	9.6	3,984.8	2.4	166,576.5	....
After erosion-control program	26,333.8	17.4	114,757.3	75.8	9,109.0	6.0	1,183.0	.8	151,383.1	....
Reductions	1,810.2	[1] 11.9	3,652.7	[1] 24.0	6,928.7	[1] 45.6	2,801.8	[1] 18.4	15,193.4	9.1

[1] Percent total reduction.

TABLE 2.—*Corn acreage estimates for 28 projects*

	A slope		B slope		C slope		D slope		Total	
	Acres	Percent of total crop	Acres	Percent of total crop	Acres	Percent of total crop	Acres	Percent of total crop	Acres	Percent total reduction, all slopes
Before erosion-control program	120,856	35.2	174,578	50.9	35,285	10.3	12,242	3.6	342,961	....
After erosion-control program	113,233	37.7	163,017	54.3	20,286	6.8	3,782	1.2	300,318	....
Reductions	7,623	[1] 17.8	11,561	[1] 27.1	14,999	[1] 35.1	8,460	[1] 19.8	42,643	12.4

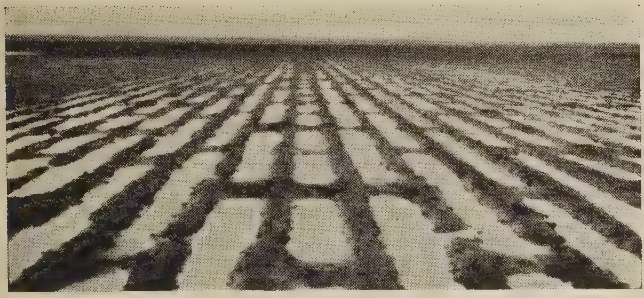
[1] Percent total reduction.

TABLE 3.—*Wheat acreage estimates for 14 projects*

	A slope		B slope		C slope		D slope		Total	
	Acres	Percent of total crop	Acres	Percent of total crop	Acres	Percent of total crop	Acres	Percent of total crop	Acres	Percent total reduction, all slopes
Before erosion-control program	19,206	24.7	41,455	53.4	15,401	19.8	1,589	2.1	77,651	....
After erosion-control program	17,901	24.0	40,806	54.8	14,448	19.4	1,340	1.8	74,495	....
Reductions	1,305	[1] 41.3	649	[1] 21.1	953	[1] 30.5	249	[1] 7.8	3,156	4

[1] Percent total reduction.

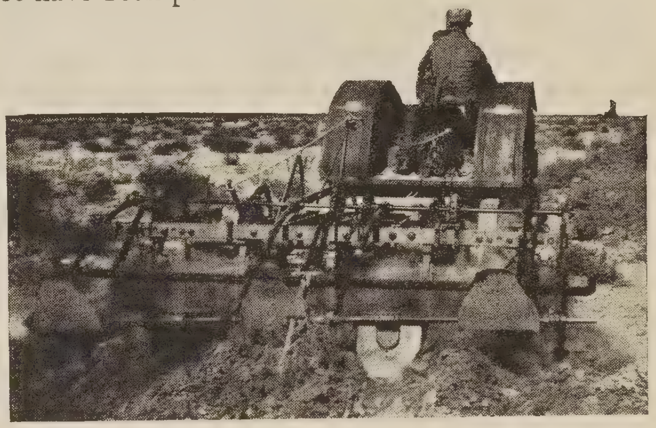
DAMMING LISTER PROVES USEFUL



Numbers of ingenious new mechanical devices are being developed by agricultural engineers, farmers, and others in the effort to conserve moisture and soil. One of the most interesting is that of C. T. Peacock, farmer of Lincoln County, Colo. Information concerning it comes from B. W. Allred, associate range examiner of the Soil Conservation Service, Colorado Springs.

The rainfall there averages 13 inches a year and comes usually in the form of torrential rain and hail. To catch and hold the water, Mr. Peacock worked out the machine shown in the illustration. Looking something like a beet cultivator, it has five plow points spaced at 20 inches. A few feet back of each plow point is an automatic attachment which drags along sufficient loose dirt to form a neat dam when tripped at 16-foot intervals. The machine, says Mr. Allred, goes deep enough to throw up a cloddy undersoil which is wind resistant.

During the last growing season the lister successfully held large quantities of water upon the land following large downpours and brought about production of large crop yields which otherwise would not have been possible.



SOME ABC's OF SOIL CONSERVATION

(Continued from page 2)

and B slopes was made incidentally to the working out of proper rotations and the use of soil-building crops which not only reduce erosion, but also increase the yields per acre.

Table 2 shows the same information for corn acreage on 28 projects in the States of Alabama, Arkansas, Florida, Georgia, Illinois, Iowa, Kansas, Louisiana, Minnesota, Mississippi, Missouri, Nebraska, North Carolina, Ohio, Oklahoma, Pennsylvania, South Carolina, Texas, Virginia, and Wisconsin. On these project areas approximately 14 percent of the corn acreage was grown on C and D slope previous to the inception of the program. This acreage has been reduced to 8 percent of the total, and corn is now grown on these slopes only where conditions are most favorable and extreme control measures are used.

Large Cut in Corn

The total reduction in acreage of corn on these 28 projects amounts to 42,643 acres, or 12.4 percent. The reduction on the A and B slopes in the case of corn is also due to the adoption of better rotations, and the increased use of soil-building crops.

Table 3 is included to show the small reduction that has been made in the acreage of wheat on the 14 projects in the States of Illinois, Iowa, Kansas, Minnesota, Missouri, Nebraska, Ohio, Oklahoma, Texas, Washington, and Wisconsin. Wheat is considered as one of the less erosible or close-growing crops in the humid sections. Most of the 4-percent reduction effected on these 14 projects has been made in the dry farming sections, where summer fallow is practiced in order to store up moisture for the production of the ensuing wheat crop. In the humid sections, especially where winter wheat is grown, it makes a fairly satisfactory winter cover, and is of especial value as a nurse or companion crop for the new seeding of grasses and legumes that play such an important part in the control of erosion and the building up of the soil. The Soil Conservation program is based on correct land use, and the adoption of proper erosion-control practices.

PLANNING A CROP ROTATION IN CONNECTION WITH STRIP CROPPING

By H. L. Thomas

Strip cropping is in high favor with farmers in the Beaver Creek Valley of Minnesota. Most of them readily see the value of this method of stopping soil losses. There are some, however, who at first hesitate to undertake it because they think first, that it will not be possible to summer pasture the fields after grain is harvested; and second, that in cutting a grain strip adjacent to a cornfield, the back swath will be so long that considerable grain will be wasted. The accompanying map sets forth a farm program which avoids both of these difficulties.

The cropping plan is as follows:

Field No.	3	4	5	6	8
Acres	11.5	9.5	12.0	16.5	4.0
1936	Grain	Corn	Grain	Corn	Grain.
1937	Hay	Grain	Hay	Grain	Hay.
1938	Corn	Hay	Corn	Hay	Hay.
1939	Grain	Hay	Grain	Hay	Corn.
Field No.	9	10	11	13	15
Acres	4.5	16.5	10.5	9.0	2.0
1936	Grain	Grain	Grain	Grain	Grain.
1937	Corn	Hay	Corn	Corn	Hay.
1938	Grain	Hay	Grain	Grain	Hay.
1939	Hay	Corn	Hay	Hay	Corn.

Fields 7, 12, 14, 16, and 19, totaling 20 acres, will be seeded to alfalfa.

Areas 2 and 18 are pasture, totaling 86 acres.

Areas 1, 20, 21, and 22 are steep timber lands which are not to be grazed.

The gullied spots, G_1 to G_6, inclusive, are fenced out to protect the engineering and vegetative control measures which will be applied.

Each year there are approximately 23 acres in corn, 23 acres in grain, and 46 acres in hay, plus the 20 acres of permanent alfalfa.

Notice that a fence divides fields 3 to 6, inclusive, from fields 7 to 16, inclusive. One of these areas is always in corn and hay and the other in grain and hay. As soon as the grain is cut, one of the areas may be used for pasturing. This is of considerable importance because during August the permanent bluegrass pasture is likely to be very poor. Since the grain strips in this rotation are always bordered by hay strips, no back swaths will be necessary except along fences. The binder can be driven on the hay stubble for the first round. Thus, two of the major obstacles in the adoption of strip cropping are removed. The map brings out these points more clearly.

Large Acreage of Hay

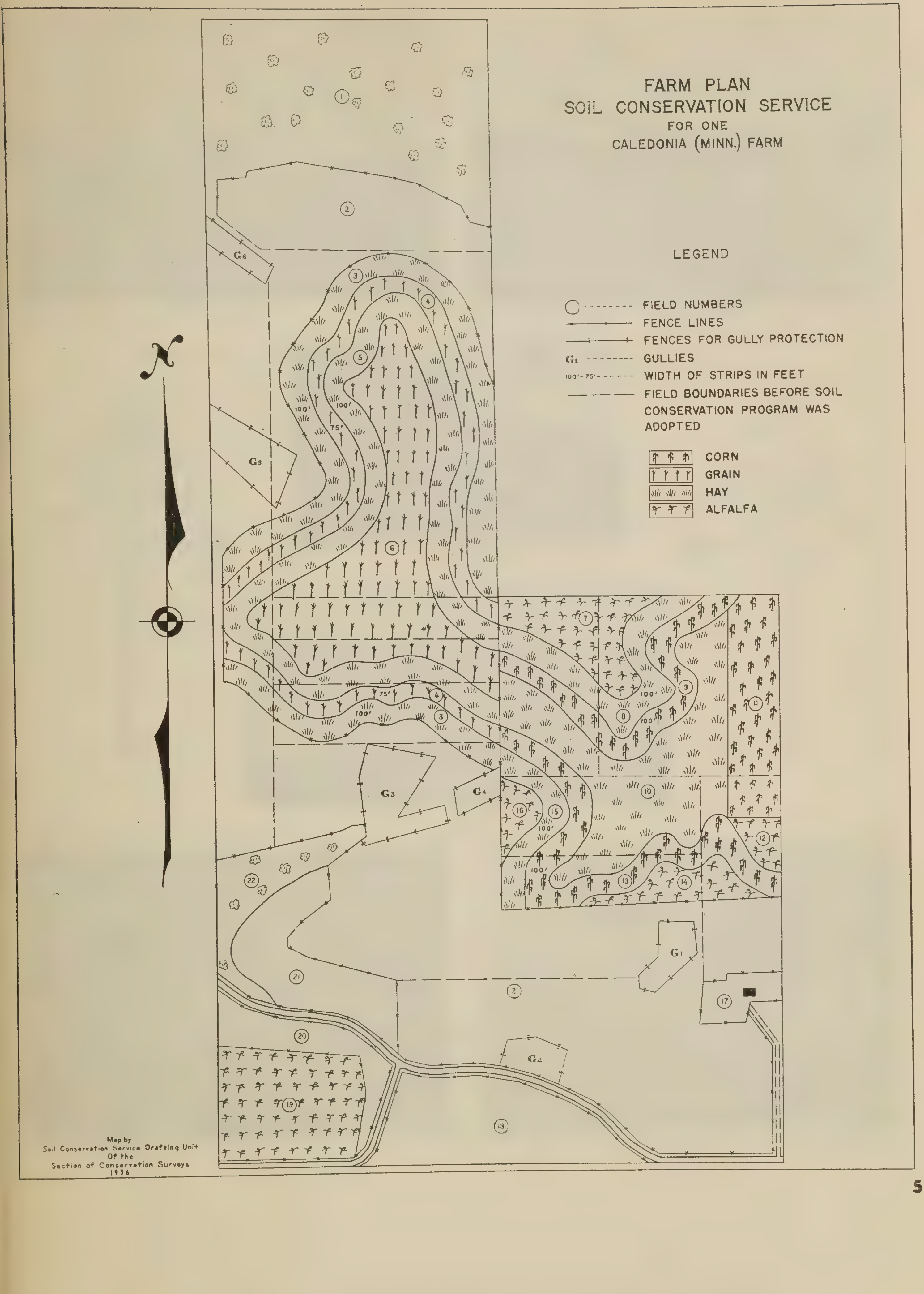
A relatively large acreage of hay and small acreage of corn is provided. This arrangement is desirable from an erosion prevention standpoint and, furthermore, it builds up soil fertility. It is particularly good farm management practice for this region if a large number of cattle are raised, as in the case of the farm in question.

Alfalfa may be used for the hay crop in this rotation, or if the operator does not find it possible to buy the necessary lime and seed, clover and timothy may be grown. Alfalfa is much the more profitable.

An alternative rotation which could be used is as follows: Fields 3, 5, 8, 10, and 15 could be seeded to alfalfa and left in this crop as long as the stand is good, perhaps 5 to 10 years. During this time the other fields could be used for a 2-year rotation of corn and grain with sweetclover which is spring plowed for corn again. Upon plowing up the alfalfa fields, they could be used for the 2-year corn, grain, and sweetclover rotation, and fields 4, 6, 9, 11, and 13 could be put into alfalfa.

Well-Rounded Program

The map of the farm also exemplifies the complete erosion control program. The gullied areas have been isolated from grazing and will be treated with the control measures which their nature and state of development demand. Field 21 is a very steep hillside from which the trees have recently been cut, and it will be replanted to trees. The other fields protected from grazing—1, 20, and 22—are rough, steep, gullied, and timbered. They can be used most economically for the production of wood and lumber, since to give them over to pasture reduces the growth of cover to the danger point. A large part of the 86 acres of permanent pasture was formerly crop land, but most of it is rather steep for this purpose. If this pasture is not overgrazed a good sod cover will keep it from eroding.


FARM PLAN
SOIL CONSERVATION SERVICE
FOR ONE
CALEDONIA (MINN.) FARM
LEGEND
FIELD NUMBERS
FENCE LINES
FENCES FOR GULLY PROTECTION
G1 GULLIES
100'-75' WIDTH OF STRIPS IN FEET
FIELD BOUNDARIES BEFORE SOIL CONSERVATION PROGRAM WAS ADOPTED
CORN
GRAIN
HAY
ALFALFA
Map by
Soil Conservation Service Drafting Unit
Of the
Section of Conservation Surveys
1936

1

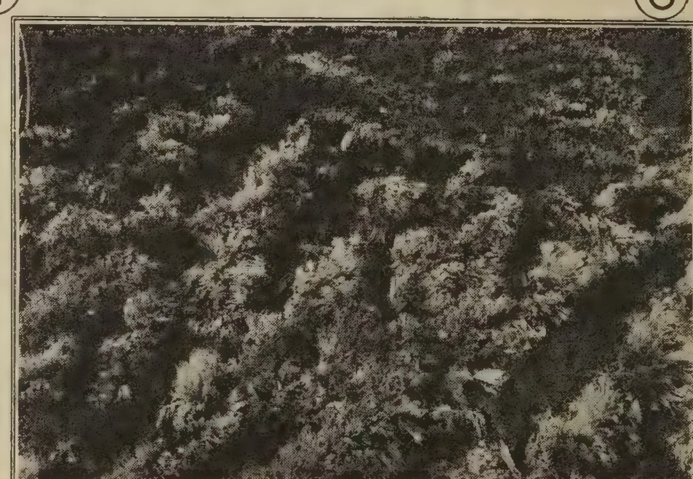
2

3

5

4

6



A NOTE ON EROSION CONTROL IN THE PIEDMONT

By Wellington Brink

The weather—not the soil—was the smoking-room topic. Streams were muddy, boiling, incorrigible. Bridges were endangered, roadbeds soggy. The train was already hours behind schedule. Human nerves were snapping. Fingers were toying with watches.

A salesman told of losing commissions. A banker fumed at missing a conference. A mill executive chafed at the cost of delay. Forward in the car people reread society pages, stock-market reports, household hints.

The Larger Tragedy

In all probability, not a single mind was occupied with the larger tragedy behind the situation: the robbery of topsoil, the silting of streams, the overflowing of bottom lands, the improvident land use which presses its problems and its burdens impartially upon city and country alike.

Here was the Dan River on one of its periodical rampages. As related in Soil Conservation in February, erosion's long fingers have been writing in red ink the journal of the stream's once amazingly prosperous watershed. Through the years they have been tallying up a depressing total of soil losses and abandoned farms, and today only the ghostly memory of a once-proud husbandry rides the field and garners the crop.

The Dan tells a familiar story—one which we see repeated on many other watersheds in Virginia and the Carolinas. Its turbulent greeting to our slow-moving train constituted an appropriate introduction to the Piedmont region with its notorious sheet washing, gullying, sedimentation, and flooding.

Here, as elsewhere, Government and farmers are today moving hopefully in research, demonstration, and improved cultural practices.

Mangum Terraces Used

At High Point, N. C. (where we stopped), it is the Deep River project. If you go to the trouble of wading ankle deep through soft red clay, you can get a good line on the effectiveness of broad-base Mangum terraces, strip cropping, and rotations. The emphasis here is decidedly on vegetative measures, although mechanical structures are given a part in the control program when their cost is justified.

Field after field is creased, wrinkled, worn. At the side of the road you note a frost action peculiar to the region; gather a handful of 2-inch crystals, each bearing at its tip a bounty of good dirt waiting for the first thaw to send it toward bottom lands, power dams, and salt seas. In this region frost must necessarily rate with wind and water in the erosional cabal.

Unruly Streams

My companion, the erosion specialist, slowed the car as we approached a stretch of road which showed the effects of the weather's recent carousal and was in need of much better grooming. Wheels sank low in the mud. There was a thin covering of debris. "That's the way our streams behave", said he. "Up one day, down the next, damaging highways and destroying farm lands as they come and go."

We stopped for a look at a tract which is part of the 24,175 acres terraced by the project. I remarked upon a small patch of corn with rows running up and down rather than on contour. "The owner insisted there was never any loss there", I was told. "But with the coming of a heavy rain we made a few rough calculations which showed half a ton of good dirt being carried down the short aisle between each two lines of stalks."

Eleven out of 13 mill ponds on Deep River have completely silted up and the whir of spindles has hushed as cotton manufacturing has sought other locations. It took but 31 years for the first dam to be made useless, 5 to 10 years more for the others to join it. Big, substantial dams of first-class masonry, representing a large investment.

PICTURES ON OPPOSITE PAGE

1. Good growth of hairy vetch on farm near Tigerville, S. C. 2. This gully was treated during summer of 1934; seeded to small grain in fall of that year; picture made Apr. 1, 1935. 3. Base of dam, Oakdale Cotton Mill, Jamestown, N. C., showing silting of mill pond. 4. Strip crop on farm near Switzer, S. C.; dark bands in oats, intervals between planted to grain; Apr. 1, 1935. 5. Broad terrace outlet ditch with rock, wire and sod spreader dams, near High Point. 6. The erosive agent known as jack frost, at work near High Point.

Stopping this waste of soils and crippling of industry is no simpler here than anywhere else. I am told that one farm in this area has 21 different soil types. Diverse soils, crops, establishments, and farming philosophies color the Piedmont and make of it a pressing challenge to soil conservationists.

Terraces straddled by strip crops; terrace outlets of rock, of tile, of wire and of sod; 2- and 3-year rotations involving corn, cotton, lespedeza, winter peas, small grains, retirement of unproductive lands: These are the shock troops of engineer, agronomist, nurseryman, forester, erosion specialist, and management expert.

They have tried many promising ideas here—lime and legumes, ingenious new machinery, plant introductions, and they've just about arrived at a simplified program of control centering on the thoroughly tested broadbase mangum terrace, strip cropping, rotation, and supplementary engineering structures, where necessary, for the control of gullies and run-off waters. They have even experimented, and with some success, with the unique waffle cultivator—first used on the erosion experiment station, Hays, Kans.—a pasture puncher which creates a 2-gallon water tank with each scoop of a shovel.

Substantial Terraces

At Spartanburg, S. C., it is the South Tyger River project. They like the Nichols terrace here—a neat, solid structure with a clearly defined water channel. It's made cooperatively, with tractor and scraper. They gouge right down into the subsoil. A year of some close-growing crop, and ordinary care, establishes the terrace as permanent, assuming that the farmer will do his part to maintain it.

They've had 2 years in which to prove the value of the Nichols terrace. And every month its strong protective arm is circling more slopes on the area. Today it is halting erosion on nearly 11,000 acres, and nearly a quarter of a million feet of terrace outlet channels are disarming the run-off waters which have such vicious tendencies in this region. It is being copied by farmers outside the project.

It's one thing to speak of 1,194,816 black locust trees having been planted in the area. It's another, to stand at the roadside and observe a dimple which was once a ditch—a growing ditch which had twice cut through the highway and was chewing again at the thoroughfare when its depredations were halted. A bulldozer sloped the banks, 400 to 500 black locust trees were planted and readily took root, the sides were banded with bermuda grass.

Yes, and there are a million and a half pines planted for purposes of anchoring soil, utilizing waste acres, creating windbreaks and game cover. There's many a good "before and after" contrast where unkempt woodlots have been accorded management for the first time—fire hazards reduced, thinning and pruning effected.

Last year they turned loose 108 pairs of quail—free to roam and multiply on the 10,000 acres signed up as State sanctuary. Wildlife conservation is a phase incidental to the complete program.

As at High Point, the principal reliance is upon vegetative measures. Noting the high frequency of corn failures, the Spartanburg staff is reducing the acreage given over to the tasseled crop and is encouraging the planting of oats. Contour farming is the rule, of course.

Experimentation

Farming is coming to be a real science down here. Take the hydraulic laboratory on Beaver Dam Creek as an example. That's where they find out exactly what happens to clay and concrete and bermuda sod when subjected to a rush of water. They've built a dam, a control flume, and waterway channels for testing the effectiveness of many types of measures and materials. They've mixed cement with native soils. They've planted and sodded and flooded. They've tried spreaders and baffles and check dams. They've subjected waterways to a wide range of volumes and velocities of flow. And already they are arriving at tentative conclusions confirming the usual adequacy of Nature's method of restraint—vegetation.

We took a look at one of the C. C. C. camps assigned to soil-conservation work. It's the one near Switzer, 12 miles out of Spartanburg. Two hundred and

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PICTURES ON OPPOSITE PAGE

1 and 2. Before and after views of a woodlot demonstration near Spartanburg. 3. Water flowing over rock masonry baffles at hydraulic laboratory; discharge approximately 13 cubic feet per second; depth of flow at baffle about 8 feet. 4. General view of dam and control flume at hydraulic laboratory; flood gate regulates amount of water entering flume. 5. Pasture on dairy farm near High Point cultivated with waffle cultivator. 6. Abandoned roadway treated for waterway; baffle boards and bands of bermuda grass used; bands 18 inches wide and 10 feet apart.

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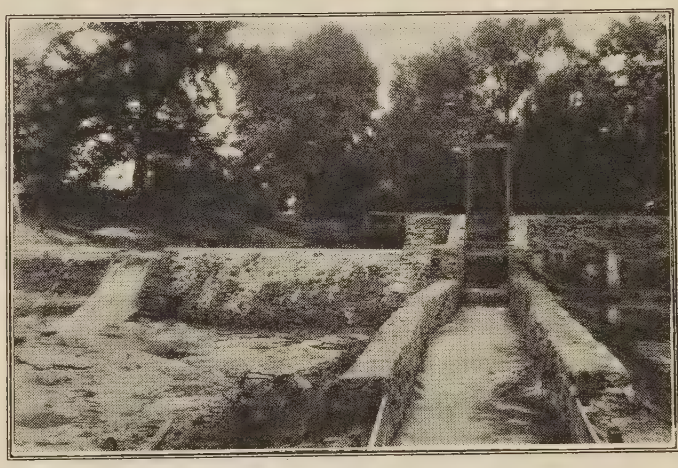

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MEADOW STRIPS IN EROSION CONTROL

By H. L. Dunton [1]

Meadow strip after seeding and liming, Aug. 16, 1935.

Keen interest attended the preparation of the first meadow strip in the Chatham, Va., project in July 1935—the first of 25 such strips to be laid out and seeded in the Banister River area.

As used here, a meadow strip serves as an outlet for terraces draining into it from bordering fields. It is located in a swale or depression which serves as a natural drain. The width of the strip varies according to the natural width of the depression, some of those already constructed being 100 feet wide. The width must be sufficient for the edges of the strip to be 1 or 2 feet higher than the center, thus eliminating the danger of cutting and gullying at either side. The wider the strip, the greater the spread of water and the less likelihood of cutting.

The length of the strip is also of high importance, as the water must be conducted slowly from the field to a point where other methods of control can be brought into play. The area of the strips so far constructed varies from an eighth of an acre to nearly 5 acres.

Many factors govern the location of a meadow strip, among them slope, drainage area, the presence of deep gullies, the existence of sufficient topsoil for a good sod, the natural width and length of the depression.

Generally speaking, meadow strips for handling the run-off waters from 15 to 30 acres should not be constructed on slopes over 6 percent. The optimum slope is about 4 percent. The presence of deep gullies usually precludes the construction of a meadow strip. A narrow depression of from 10 to 15 feet in width that cannot be widened is not usually suitable. Factors determining the location of a meadow strip are interdependent and no arbitrary rules are possible.

Nearly always a certain amount of machine grading is necessary. Grading provides a slight slope toward

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[1] The author is now extension agronomist with the Virginia Polytechnic Institute. He was formerly with the Soil Conservation Service at Chatham, Va.

Same meadow strip, Sept. 24, 1935.

EROSION CONTROL IN PIEDMONT

(Continued from page 8)

twenty young chaps there—happy, jolly, husky from their outdoor life, interested in their work. I lifted the hood of a big truck, found the engine clean as a new whistle. There's a reverence for tools, equipment, trees, soil. Many of these enrollees come from farms, and they will take back home their acquired knowledge of gully-checking and erosion control.

Piedmont farmers are applying the lessons of the project demonstrations. Farm after farm outside the areas are putting up defenses—mechanical and cultural—against the assault of the elements.

Will all this have any appreciable effect or will the Dan and the Deep and the South Tyger and their companions continue indefinitely to carry away the basic wealth of the watersheds? Soil conservationists think not. They believe that the hydrologic stations set up at strategic points along streams will in time record material improvement—that their data will prove that a positive check has been put upon erosion in the treated areas, and point to a gradual reversal of the trend in land use.

MEADOW STRIPS

(Continued from page 10)

the center, draws the water from each terrace, causes a spreading rather than a concentration of water at each terrace end.

Temporary Ditches Cut

After grading and seeding, temporary ditches are cut around the strip to keep excess run-off water from injuring the new seeding. With the establishment of a good sod, these temporary ditches are filled and the water from the terraces allowed to empty onto the strips.

Every effort is made to obtain and to maintain a good substantial sod, by the use of lime, fertilizer, and a mixture of grasses, clover, and lespedeza. Spots of low fertility are usually mulched to assist in sod establishment. Hard rains shortly after seeding often cause small washes which should be immediately mended by using good soil and reseeding. A complete sod is essential. To insure permanency the farmer should fertilize and lime the strip in the future. It is also important to clip the grass on the strip, thus affording a goodly amount of quality hay. A meadow strip properly cared for will prove to be very profitable in many ways.

The principles involved in the construction of meadow strips, as described above, can be used on many farms. Small drainage ways or gullies in a field may be prepared for seeding, limed and fertilized, mulched, and allowed to remain in grass.

REGIONAL AGRONOMIC CONFERENCES

Regional conferences of project managers, agronomists, nurserymen, and other Soil Conservation Service workers were held at Albuquerque, N. Mex., January 20–24; Amarillo, Tex., January 27–28; Stillwater, Okla., January 30–31; and Huron, S. Dak., February 3–4. Several State agricultural experiment station, extension, and Forest Service men also took part in the conferences. At each meeting committees recommended policies and procedures to guide those doing agronomic, pasture, and range-management work.

Handbook Contemplated

In region 8, the Southwest, the program was directed toward the development of a handbook covering soil-conserving plants, agronomic and range-management practices, and their use in our work.

In the Southern Great Plains wind erosion region, no. 6, reports covering the principal features of the work of each project were followed by the discussion, amendment and adoption of committee reports concerning land management on the major soil types, cultural practices for the principal crops, the revegetation of land to be retired from cultivation, and the restoration of the range.

Rotations Discussed

In region 7, the Central Great Plains, the program included reports and discussions of representative projects for each district of the region, and the reports of committees concerning crop rotations and cultural practices for the several areas where cotton, wheat, and corn production and mixed farming predominate. Recommended methods of revegetating abandoned land and desirable pasture and range-management practices were also discussed and made a part of the regional policy in soil conservation.

Wind Erosion

In region 9, the Northwest, the program consisted of a presentation of the principal methods of controlling wind erosion, such as crop selection and rotation, seeding and tillage methods, and strip cropping; project reports and committee reports which were adopted to serve as the basis for the agronomic and range management policies of the region.

In each of the regional conferences, the work of the nurseries was discussed and plans were developed for apportioning and distributing the seeds collected during 1935, and the plants available in the nurseries, as well as for future plantings and collections. The most urgent problems requiring research were also discussed and recommended to the research staffs.

Plans are being made to hold similar conferences in the other regions of the Soil Conservation Service, beginning the second week in March.

KUDZU IS THIS FARMER'S FRIEND

By E. M. Rowalt

Kudzu came out of Japan and somehow got onto porches in Alabama. Porch vine, they call this legume down there. Now the S. C. S. boys are using it, by the acre. They're retiring 3 percent of the land to it, I was told by R. Y. Bailey. And some of the natives are shaking their heads. "What are we to do with all this porch vine?" they ask. "Feed it, graze it, cut it for hay", Bailey answers, and dropping into the vernacular of the agronomist, he adds, "It compares favorably with alfalfa." But the kudzu story is not merely "feed values", it's "soil binding." It literally ropes land down. Everybody in Alabama knows this, and that is why some are afraid of it. "It might take our fields." This prejudice is gradually being overcome, but many are still skeptical about its feed value. They can't believe porch vine will make good feed. And so, when R. Y. Bailey finds testimony of kudzu feeding worth outside experiment station reports, he takes it down. There follows the report of John Wooddy, Camp Hill, colored farmer, as told to a stenographer.

I never had no mule when I fust moved here. I got the mule a few days after I moved, along the last of March. The mule was dead po'. I met Mr. Judge Johnson in front of his house when I was going on to town to have her shod and he said, "What I had?" I said, "A mule", and he just laughed. When I passed on by his store he told me to come by a minute and I went on in the store and he told me to be particular and I asked, "What?" He said, "They are right in behin' you and if you don't mind they are going to catch you", and I sed, "I ain't done nothing to catch me for", and I sed, "Who, Mr. Johnson?" and he sed, "A crowd of buzzards."

Skeptical as to Mule

I come on down the road to Mr. Earnest Mooney's and him and his wife and his chillun, they all come out to the road looking at the mule. Mrs. Mooney, she sed I mought git home with her but told me I had better be particlar crossing the bridge down there as

the buzzards mought catch me as they roosted down the creek.

My brother-in-law asked me if that was what I was going to farm with and I told him, "Yer." He sed I had better just as well go somewhere and try to git a job cause that mule will be dead 'fore Satday night.

No Better Off

I come on home and my wife, she sed, "You ain't no better off, you had a steer last year and nothing to eat and this year, you have something to eat and nothing to plow."

When I fust got the mule she got down and we would have to help her up. When I was feeding her, some would say not to feed her too much it mought kill her. I didn't see her git no better 'till I fust started to cutting kudzu and feeding it to the cow. On the 15th day of April was the fust day I started to feeding the mule on kudzu. It was not over 4 or 5 days after that before she got where she could git up and down by herself and has been picking up ever since. If you feed her sweet feed and kudzu, she will eat the kudzu 'fore she will the sweet feed. They say she has picked

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EVEN POOR COVER IS BETTER THAN NONE

By M. E. Musgrave [1]

Be it ever so humble, there is nothing like cover. In the Navajo country no bit of growing vegetation is looked upon with scorn.

When the Nakai Bito Experiment Station was fenced in the late fall of 1933, there was no difference in appearance between the range inclosed and that without. In the bottom of the washes, on their deltas, on the farm lands and on the low hills was an abundance of sand which the prevailing winds, from the southwest, kept constantly on the move. Soon our east-and-west fences were piled high with sand and brush. Russian thistle, or tumble weed, formed the greater part of this deposit, although in some places sand alone would lodge against a mesh wire or even a five-strand barbed wire fence.

Two Areas Watched

Two areas which were nearly identical at the beginning of the windy season of 1933 provided us with an interesting study. Both plots lay alongside a fence, but to the south of one we had no control over livestock, while the land south of the other area, although outside the fence, was under our direction. Here we permitted no livestock within 2 miles of the fence. In a short time there was a very marked difference. The land below the first area, constantly trampled and loosened by the feet of stock, was soon in the air. Thousands of tons of good top soil were blown away. Some lodged against our fence. Much of it drifted through, covering the vegetation to a depth of from 18 to 36 inches. Farther from the fence line, the effect was not so detrimental. The grass caught a certain amount of the blowing sand, depositing it around the plants and thus creating a mulch which conserved moisture and helped to preserve plant life.

Thistle Takes Hold

On the other area, there was at first a sand deposit along a north fence. But, under protection, Russian thistle and such native grasses as alkali sacaton, Hilaria, foxtail and grama soon grew up. The thistle remained on the ground throughout the winter, with the exception of a few small clumps exposed to the wind. As a consequence of this ground cover, sand blowing was almost completely stopped. The windrow of sand formed along the fence within a few months became covered with a dense stand of seedling Russian thistles.

I have often heard the charge made that Russian thistles are taking the country. And, yet, in some places the Russian thistle has proved to be nature's last dependence. If it had not been for the Russian thistle on a large part of the Navajo country, there would probably have been little land left, since in many places the soil is very shallow. While it isn't the best of forage, the Navajos have been able to lamb their sheep on these weeds.

Any cover at all is better than none, and where the poorest can hold on for a time, it may prepare the way for a better type later.

[1] The author is senior soil conservationist, Soil Conservation Service, Albuquerque, N. Mex.

KUDZU, FARMER'S FRIEND

(Continued from page 12)

up 200 pounds, so they tell me, I don't know. Mr. Judge Johnson sed for me to bring her to town he wanted to weigh her. Sed he didn't believe she was alive. He don't believe I made my crop with the mule but I did not have no help 'cept with her.

Surprising Crop

Mr. Frank Wrenn told my dad-in-law that he ought to see my crop. He sed he never seen nobody or no horse doctor take care of a mule and brought the mule out any better than I did. Sed he ought to come and see my crop and the mule.

It has been 3 weeks ago I passed Mrs. Mooney's agin and she was a-coming from the cowpen and she stopped me and looked at the mule and sed, "Don't you tell me that that is the hide and cocklebur that you carried on by here about 2 or 3 months ago." I told her, yesmam that she was.

Milk Increased

I had a milk cow when I come over here. The calf was 'bout 8 months old. She was dry, only give about 1 pint of milk a day. I told my wife I believed the cow would come back to her milk if she had something to eat. She sed, "No, she never would come back to her milk until she found another calf." After we went to

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STUDY SHOWS HIGH COST OF EROSION TO HIGHWAYS

Erosion caused more than one-third of all damage to 194.3 miles of highway on which records were kept for 16 weeks.

This conclusion is drawn from preliminary figures of a 12-month study being conducted cooperatively by the Soil Conservation Service and the highway commission of Vernon County, Wis. The study hinges upon weekly reports of 25 road patrolmen of the county, which is typical of the naturally rough topography of the so-called "driftless area" of southwestern Wisconsin, southeastern Minnesota and parts of Iowa and Illinois. In this area the S. C. S. is demonstrating erosion-control methods on seven different watersheds.

Highway patrolmen in this county are engaged in (1) routine work such as smoothing the road surface, drainage, cutting brush and weeds along roadsides, constructing guard rails on culverts and bridges, resurfacing old and new sections worn by traffic, repairing shoulders, filling joints on concrete highways, patching traffic-worn spots on concrete or tarvia surfaces, and (2) work done as a result of erosion, such as clearing away stones and other debris, repairing culverts and bridges after floods, filling in or resurfacing washed spots, clearing ditches, and repairing dams built in road ditches to care for flood waters.

Patrolmen were furnished with a mimeographed form providing spaces for the foregoing divisions of work, and instructions for reporting upon them. Fifteen of the patrolmen have kept records sufficiently accurate for use in the summaries which follow.

Patrolman's file number	Miles of road patrolled	Number of weeks [1] covered by reports	Hours, erosion work	Total hours, all work	Percentage of work necessitated by erosion
1	10.8	16	512	892	57.40
2	14.0	12	273	686	39.80
3	13.0	12	190	700	27.14
4	14.5	16	197	954	20.65
5	5.5	16	122	958	12.73
6	14.5	15	331	946	34.98
7	13.0	14	159	777	20.46
8	16.5	14	383	840	45.59
9	7.0	11	383	648	59.10
10	14.0	16	243	909	26.73
11	16.0	16	290	960	30.20
12	11.5	16	219	936	23.40
13	20.0	14	248	672	36.90
14	13.0	15	397	794	50.00
15	11.0	16	294	924	31.82
Total	194.3	219	4,241	12,596	[2] 33.67

[1] Reports cover a maximum of 16 weeks starting May 19 and ending Sept. 7, 1935.
[2] Average.

The proportion of time spent on road work to offset damages from erosion and floods, as shown by the above data, is enough to cause great concern over the damage from these sources. As a matter of fact, extra crews were used on some parts of the 194 miles of highway after heavy floods and severe damage from erosion had occurred, and their time was not recorded in the summary.

It is safe to assume that those roads, passing through areas where all adjoining farms are now operated according to erosion-control plans, will be less subject to serious damage from erosion and floods in the future. It probably will be impractical, because of wide variation in weather conditions, to estimate the value of controlling erosion on adjoining lands, in terms of the reduction of erosion and flood damage to highways. It does, however, seem very logical that reforestation of steep woodland areas, construction of gully-control structures, terracing of the more level ridge lands, contour tillage, and strip cropping, along with better pasture management, will aid importantly in reducing the damage caused by excessive run-off water.

Arrangements have been made to continue this study until May 19, 1936.

KUDZU, FARMER'S FRIEND

(Continued from page 13)

feeding her on the kudzu, in about 2 weeks she picked up somewhere along about 1 gallon of milk a day and my wife sed she believed she would come back to her milk if we just increased the kudzu with her and we did and it come on up to 2 gallons a day.

When you come in from the pasture with the cow and have a pile of kudzu and she gits a sight of it, she kicks up her heels and runs to it. I feed her on kudzu twice a day. She is in the lot now and if you will carry her some kudzu, she will come and meet you.

I have a sow that brought pigs 'bout first of May. She ain't had a mouthful of nothing to eat 'cept kudzu vines and the slop from the kitchen. The pigs they be 7 weeks old today. I have been feeding the sow on kudzu ever since before the pigs was born and have been feeding her on it ever since. The pigs are pretty. Course the sow is sorta off but I have seed sows that was fed that was in worser shape than she is.

SOIL CONSERVATION AND THE NORTH AMERICAN WILDLIFE CONFERENCE

By William R. Van Dersal [1]

Upon invitation of the President of the United States there met in Washington, D. C., February 3 to 7, 2,500 persons interested in the conservation of natural resources, particularly wildlife. The conference met to attempt to organize into a unified, coherent group the individuals and organizations most concerned in the restoration and conservation of wildlife. It was recognized clearly that differences in outlook among certain factions have led to a notable waste of energy in the past, while our wildlife resource has continued to dwindle. Protectionists and sportsmen appeared at the meetings, determined to find a common ground in order that concerted action might be taken to restore and perpetuate for posterity the wildlife resources of the continent.

Common Ground Found

Essentially, that common ground was found. With the formation of the General Wildlife Federation, for the first time the possibility looms that "adequate public recognition of the needs and value of wildlife" may be attained. With Jay N. Darling, as president, the federation has dedicated itself to accomplishing the objectives of a national and continental plan for the organized development of the wildlife resource.

The conference included meetings of a general nature wherein were discussed the wildlife crisis of the continent, the resources of the Nation, the organization of all wildlife interests into a federation, and the possible solutions to the problems of wildlife conservation. In groups, meeting concurrently, were considered basic problems of wildlife management and game breeding, farmer-sportsmen cooperatives, fur resources, pollution, stream and lake improvement, wildlife diseases, and forests and forest wildlife. Exhibits set up by various Government agencies and other organizations demonstrated visually the part played in national economy by wildlife conservation.

Revegetation Favored

The relation between proper land use and wildlife conservation was clearly seen and pointed out by many speakers. The control of erosion through revegetation as practiced by the Soil Conservation Service was shown to bear definitely and fundamentally on the restoration of wildlife habitats, and the improvement of conditions for birds, fish, and mammals.

Said Ernest G. Holt, head of the section of wildlife management, "There can be no real wildlife conservation" in the absence of soil conservation. This is basic, fundamental. . . ." The ruined acres destroyed by erosion cannot support the necessary food and cover plants essential to wildlife existence, he continued and the "reckless abandon with which we have ripped off . . . protective covering of vegetation" has been a "real factor in the disappearance of our farm game. . . . With revegetation the keynote of the soil conservation program, wildlife management in the Service largely resolves itself into proper coordination of erosion control operations so as to obtain the desired environmental controls."

Acknowledging the tremendous task before the newly created federation, Mr. Holt pointed out that, "If the salvation of our wildlife is a job too big for any one agency, how patent it is that the salvation of our soil, on which all life depends, is a task that demands the concerted and determined action of the whole Nation!"

The organization of this group of people for the avowed purpose of conserving a national resource is one of the signs of the times. As a Nation we are beginning to awaken to the necessity of using wisely that we may not lose entirely the remainder of the once-bountiful heritage of our land. It is to be hoped that the new General Wildlife Federation may work with us as we work with them, in assuring to posterity a properly conserved, valuable resource of wildlife.

[1] The author is biologist with the Soil Conservation Service.

FUTURE MEETINGS OF INTEREST TO S. C. S. WORKERS

American Society of Mechanical Engineers. Week of June 15th, 1936. Dallas, Texas.

International Conference on Soil Mechanics and Foundation Engineering. June 22–26. Harvard University.

World Power Conference, Congress of International Commissions on Large Dams. September 7–12, 1936. Washington, D. C.

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

A contribution from the Soil Conservation Service Library

POSSIBILITIES OF SHELTERBELT PLANTING IN THE PLAINS REGION.

Prepared under the direction of the Lake States Forest Experiment Station, United States Forest Service. 1935.

This is a report of the shelterbelt forestation program involving approximately 114,700 square miles of land within a 100-mile-wide zone extending through the prairie-plains region from the Canadian border southward into the Texas Panhandle. Climatically this region is a transition zone between the humid region to the east and the semiarid region to the west, embracing all gradations between the two. It is characterized by low annual precipitation occurring mostly during the summer, frequent droughts, great range in temperature extremes, low humidities, and almost constant winds of comparatively high velocities. The land surface varies from level to rolling. The typical soils are the Chernozem and chestnut-colored soils, with considerable areas of dune sand. Hot desiccating winds are of frequent occurrence in summer. In winter, cold winds and blizzards are common, while in spring the region is often visited by devastating dust storms.

As time passes, agriculture in the Great Plains region becomes more and more hazardous. Frequent long drought periods and consequent dust storms have resulted in increasing economic losses and human and wildlife suffering. The drought of the last few years clearly brought into focus the urgent need for coordinated and planned use of the plains and prairies for the prevention of desert formation.

This report, the work of 14 authorities in forestry, deals with the results of investigations preliminary to the launching of the plains shelterbelt project, and the first season's procedure during the latter half of 1935, in the planting of 6,800 acres of young trees.

Much space is given the subject of soil and forest relationships of the shelterbelt zone. The results of many years of work by the Bureau of Chemistry and Soils and the agencies of the several States are available, and these are fortunately supplemented by the soil erosion reconnaissance survey made in 1934 by the Soil Conservation Service. Consequently, a main task of the Forest Service and cooperating agencies, in compiling shelterbelt data, was to make a canvass of the territory, carefully correlating soil-type classifications, observing kinds and conditions of tree growth, and referring each group of trees to its place on the soil map.

A large section of the report is devoted to a general description and grouping of the soils of the shelterbelt zone, with classification of trees with regard to rooting depth and habit of growth. None of the factors contributing toward soil development is uniform throughout the proposed shelterbelt area. The semiarid climate and especially the grass vegetation have, however, given the soils of the region as a whole two outstanding features, namely, dark topsoils containing a greater or lesser proportion of black decomposed organic material, and a zone of calcification or lime enrichment at a shallow depth in their subsoils, marking in a general way the lower limit of water percolation from the surface. These features are present in varying degrees in the soils of 85 percent or more of the area.

The root systems of 125 trees and shrubs occurring in the shelterbelt zone, 84 on fine-textured and 42 on sandy soils, were examined during the process of survey, the point of chief interest being the depth of root penetration in the different soils. It was found that rooting is invariably deeper in sandy than fine-textured soils in all localities where the water table is beyond reach of tree roots. Among the fine-textured upland soils, however, rooting is deeper in those developed from loess than in those from other geologic formations, that is, in the loess-derived soils of Nebraska and northwestern Kansas. Rooting is shallowest in the fine-textured drift-derived soils of the Dakotas. The roots of most trees are most numerous above the zone of lime enrichment, within the upper 2 or 3 feet of the soil profile where such factors as moisture, nutrients, aeration, temperature, and soil organisms are most favorable for growth.

A chart is included in the report representing graphically the occurrence and the ecological value of species of native trees and shrubs in the shelterbelt zone. Of the 73 trees and shrubs considered of ecological importance within the zone and included in the chart, 40 are found in the North Dakota section, 43 in South Dakota, 49 in Nebraska, 41 in Kansas, and 50 in Oklahoma and Texas. The trees and shrubs native to the areas are more drought-resistant than representatives of the same species growing under more favorable moisture conditions.

The amount of ground water within the shelterbelt zone, not including the soil and subsoil moisture, is far greater than that of the surface water and considerably greater than the volume of annual rainfall. It supplies wells, subirrigation, and springs. A knowledge of the location of areas in which the water table lies at depths of 5 to 20 feet is invaluable, because such localities offer the best possibilities in the shelterbelt zone for tree planting, from the point of view of growth and longevity. The distribution of the water-bearing formations of the zone is shown by accompanying areal geologic maps and cross sections.

In its origin the Plains Shelterbelt Project received public support largely as a measure for immediate relief of drought-stricken farmers. It should be pointed out that the immense program will require a large amount of local labor and provide considerable cash income to farm families for many years to come. Likewise, thousands of instances have been reported in which crops have been benefited by plantations of trees. Shelterbelts prove particularly advantageous in the protection of orchards and gardens, farmstead buildings, and livestock; and there remains no doubt whatever as to the adequacy of any type of windbreak or shelterbelt in the prevention of soil blowing and gullying.

LITTLE WATERS. By H. S. Person, With the Cooperation of E. Johnston Coil and Robert T. Beall. November 1935.

This is a compilation of scientific data from various Federal, State, and private agencies, with findings and recommendations for utilization and control of small streams. Contains a brief, comprehensive outline of the essential aspects of the hydrologic cycle, with an analysis of absorption and infiltration variations in connection with damage to ground-water supplies by improper drainage and the removal of forest and sod cover. There are constructive suggestions for contour plowing, terracing, and strip-planting in headwater areas, as well as check-dam construction in gullies and streams.

Accompanying charts illustrating soil and water losses through cultivation in little water areas. Forty-five fine photographs showing little-water gullying in varying stages, check dams and grass and forest cover as erosion-retarding agents, contour plowing and terracing, strip-cropping, reservoirs.

SOME PUBLICATIONS ON SOIL CONSERVATION AND RELATED SUBJECTS

Compiled by Etta G. Rogers

(It is suggested that publications be obtained directly from the State Colleges and Experiment Stations publishing them)

About Soil Testing. Leaflet No. 12. Extension Service, University of Utah. Salt Lake City, Utah.

Agricultural Land Classification and Land Types of Michigan. Special Bulletin No. 231. Extension Service, Michigan State College, Lansing, Michigan.

Alfalfa and Sweet Clover on Irrigated Land. Bulletin No. 158. State College of Washington, Pullman, Washington.

Alkali Soils in Montana. Bulletin No. 172. Agricultural Experiment Station, University of Montana, Bozeman, Montana.

Classification and Agricultural Value of New York Soils. Bulletin No. 619. Agricultural Experiment Station, Cornell University, Ithaca, New York.

Comparison of Rotational and Continuous Grazing of Pastures in Western Washington. Bulletin No. 294. Agricultural Exper ment Station, State College of Washington, Pullman, Washington.

Controlling Gully Erosion. Bulletin No. 271. Missouri College of Agriculture, Mumford Hall, Columbia, Missouri.

Control Soil Erosion by Crops, Terraces, and Dams. Circular No. 249. College of Agriculture, Madison, Wisconsin.

Coping with Sand Storms. Bulletin No. 148. College of Agriculture, Madison, Wisconsin.

Drainage of Lands Overlying an Artesian Ground Water Reservoir. Bulletin No. 242, Agricultural Experiment Station, Logan, Utah.

Economic Phases of Soil Erosion Control. Bulletin No. 333. Iowa Agricultural Experiment Station, Ames, Iowa.

Economic Relation of Tractors to Farm Organization in Grain Farming Areas of Eastern Washington. Bulletin No. 310. State College of Washington, Pullman, Washington.

Effect of Calcium and Phosphorus Content of Various Soil Series in Western Washington upon the Calcium and Phosphorus Composition of Oats, Red Clover, and White Clover. Bulletin No. 243. Agricultural Experiment Station, State College of Washington, Pullman, Washington.

Effect of Fertilizers on Crop Yields of Different Soils and on the Composition of Certain Crops. Bulletin No. 274. Agricultural Experiment Station, State College of Washington, Pullman, Washington.

Erosive Effects of Heavy Summer Rains in Southeastern Washington. Bulletin No. 271. Agricultural Experiment Station, State College of Washington, Pullman, Washington.

Farming Systems for Eastern Washington and Northern Idaho Bulletin No. 187. State College of Washington, Pullman, Washington.

Fertilizer Problems and Analysis of Soils in California. Circular No. 317. Agricultural Experiment Station, University of California, Berkeley, California.

Fundamental Principles Governing the Control of Groundwater. Bulletin No. 244. Agricultural Experiment Station, Logan, Utah.

Growing and Management of Pastures in Western Washington. Bulletin No. 155. State College of Washington, Pullman, Washington.

Irrigation by Flooding in the Big Bend Section of Washington. Extension Service Bulletin No. 148. State College of Washington, Pullman, Washington.

Land Utilization and Classification in New York. College of Agriculture, Cornell University, Ithaca, New York.

Maintenance of Crop Production on Semi-Arid Soil. Bulletin No. 138. State College of Washington, Pullman, Washington.

Management Possibilities for Ring-Necked Pheasants and Hungarian Partridges. Division of Conservation, State of Ohio, Columbus, Ohio.

Measuring Water for Irrigation. Bulletin No. 588. Agricultural Experiment Station, University of California, Berkeley, California.

Nature and Distribution of Types of Farming in Washington. Types of Farming Series. Part III. Bulletin No. 301. State College, Pullman, Washington.

Net Requirements of Crops for Irrigation Water. Bulletin No. 149. Extension Service, State College, New Mexico.

New Method of Mechanical Analysis of Soils. Bulletin No. 52. Agricultural Experiment Station, Logan, Utah.

Pasture Irrigation. Bulletin No. 313. State College, Pullman, Washington.

Planting the Standard Windbreak. Special Bulletin No. 168. University of Minnesota, Minneapolis, Minnesota.

Pocket Gopher Control. Leaflet. University of Minnesota, Minneapolis, Minnesota.

Production Method of Valuing Land. Bulletin No. 326. Agricultural Experiment Station, Iowa State College, Ames, Iowa.

Reaction of Certain Ornamental Trees and Shrubs to Liming. Bulletin No. 250. Agricultural Experiment Station, Rhode Island State College, Kingston, R. I.

Saving Soil by Use of Mangum Terraces. Circular No. 290. University of Illinois, Urbana, Illinois.

Soil and Fertilizer Studies by Means of the Nenbaner Method. Bulletin No. 399. Extension Service, Purdue University, La Fayette, Indiana.

Soil Erosion in California: Its Prevention and Control. Bulletin No. 538. Agricultural Experiment Stations, University of California, Berkeley, California.

Soil Erosion in Missouri. Bulletin No. 349. Missouri College of Agriculture, Columbia, Missouri.

Soil Fertility Losses Under Missouri Conditions. Bulletin No. 324. Missouri College of Agriculture, Columbia, Missouri.

Study of Methods for the Preparation of Permanent Soil Profiles. Bulletin No. 201. Oklahoma Experiment Station, Stillwater, Oklahoma.

Terracing to Reduce Erosion. Bulletin No. 172. Agricultural Experiment Station, Ames, Iowa.

The University and the Erosion Problem. University of Wisconsin, Madison, Wisconsin.

Torrential Floods in Northern Utah. Bulletin No. 92. Agricultural Experiment Station, Logan, Utah.

Types of Farming in Nebraska. Bulletin No. 244. Agricultural Experiment Station, University of Nebraska, Lincoln, Nebraska

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WELLINGTON BRINK — EDITOR

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

H. H. BENNETT
Chief, Soil Conservation Service

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COOPERATIVE EFFORTS LAUNCHED TO CONTROL EROSION ALONG HIGHWAYS

By T. B. Chambers[1]

In recognition of the seriousness of erosion along highways in all parts of the United States, Thomas H. MacDonald, Chief of the Bureau of Public Roads, recently proffered to the Soil Conservation Service the cooperation of his agency in the study of control methods. The suggestion was eagerly welcomed by Mr. Bennett, who at once named a committee to work out cooperative relationships between the two bureaus.

Whole Country Affected

The problem to be met lifts its head at almost every roadside. It is not confined to any one section of the country. The pictures accompanying this article are an indication of conditions to be found in widely separated localities. Any traveler sees rills and gullies busy filling highway ditches, clogging drainage structures, and otherwise damaging traffic lanes and adjacent lands. He observes roadside ditches eroding and developing into gullies destructive to roads they were designed to protect. He finds gullies resulting from berm ditches; unprotected drainage channels carrying concentrated water that erodes farm lands and sometimes creates overfall gullies to menace highways; gullies cutting headward above highways that could have been forestalled by protection to banks or correction to structures where the overfall developed.

Officials responsible for construction and maintenance of highways have a definite responsibility for correcting such conditions as these. As a general rule they recognize this responsibility and on occasions they have made attempts to shoulder it. The conditions under which they work do, however, require that a maximum number of miles of roads be constructed with the available funds. Because of this, it often happens that features tending toward efficient erosion control and more economical maintenance are omitted from the original construction plans. When highway officials become convinced that there are erosion-control practices which have been tested and proved satisfactory for their particular conditions, and which if put into use will reduce the annual cost of highway maintenance, will make highways more useful, and will at the same time contribute toward roadside beautification, they are pretty likely to embrace them wholeheartedly.

Involves Soil Conservation

The soil conservationist has a very definite responsibility in developing and demonstrating erosion-control practices adaptable to highway use. He is interested primarily in erosion control as such and

[1] The author is head of the section of engineering, Soil Conservation Service.

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Highway culvert washed out. One mile west of Hokah, Minn.

is not subjected to the multiplicity of problems confronting many highway officials. From his experience he should have acquired a good knowledge of what measures will be most successful. He approaches the problem not from the single standpoint of soils or engineering, agronomy or forestry, but comprehensively, in an effort to correlate structures, vegetation, soil type, and climate. He is probably more interested in soil conservation than any other group—and erosion control along highways is assuredly a phase of soil conservation. Unfortunately, experience and knowledge are limited to such extent that demonstration blends with experimentation. Instead of recommending practices to be followed over large sections, he must cautiously design his works on small experimental scales. It stands to reason that the demonstrations should be numerous and varied, covering only short sections of roads, but containing as many problems as possible, to the end that whatever solutions are derived will be widely applicable.

Roadside erosion control invites cooperation. The Soil Conservation Service has the personnel and facilities for conducting demonstrations within the limits of its watershed projects, or within the E. C. W. camp work areas. Cooperation of highway officials can generally be obtained; in many cases they are eager that the work be carried on. The National Research Council through the Highway Research Board has recognized this problem as being of national importance, and is at present cooperating with the Bureau of Public Roads, various State highway departments, the Tennessee Valley Authority, and the Soil Conservation Service, "to study methods and demonstrate practices, materials, structures, and plants best adapted for the prevention of erosion along highways under varying conditions of cross-section, soil type, and climate."

In the cooperative scheme the Highway Research Board will act as a clearing house for assembling, analyzing, compiling, and disseminating information secured from the demonstrations.

Other agencies, including garden clubs, civic leaders, and some State highway departments, are interested in roadside beautification. Fortunately, beautification of highways by planting lends itself to

Scene in South Carolina

This gully is very active, advancing towards a county public road and also eating back into the field. This is the result of water entering from the road. The banks have since been sloped and vegetation planted.

Scene in South Carolina

This stream had a clearance of about 12 feet when the bridge was constructed some 14 years ago. At the present time silting has ruined 4 acres of good bottom land and reduced the clearance to about 18 inches.

Scene in Wisconsin

Raw road cut erosion, formed by water drainage from above.

Scene in South Carolina

Active roadside gully formed in old roadbed. Note new location of roadbed. This is the way many gullies in the Piedmont region are formed.

Scene in Missouri

Small gully as result of highway water running through. This was timothy sod, with no gully and was plowed in the spring. This gully washed by the middle of June.

Prepared by Soil Conservation Service Drafting Unit

erosion control and, conversely, erosion control lends itself to beautification. The landscape architect will be a motivating force in the work.

Land Owners Must Help

Owners of adjoining lands must cooperate, also, if best results are to be obtained. It will often be necessary to obtain wider rights-of-way to provide sufficient space for bank sloping and rounding operations. In a great many locations it will be necessary to extend control features some distance from the right-of-way, in order that gullies may be treated or drainage channels protected. Some protection to watersheds above the highway may be necessary to prevent damage to highways from excess run-off or deposits of silt.

The immediate objective will be protection and beautification of existing highways by structural and vegetative methods of erosion control. Such methods will demonstrate proper cross section with relation to soil type, climate, and vegetation; methods of protecting roadside ditches and treatment of cross-drainage channels above and below highways.

Lessons From Experience

The cross section, slope of banks and widths of berm and ditches, is a phase of highway construction that has not kept pace with the great improvements that have been made in pavement design in the last few years. In many locations the old set rules of 1 to 1 slopes on cut banks, and 1½ to 1 slopes on fill banks apply at the present time as in the early days of railroad construction. Experience in erosion-control work has indicated that in order to establish economically a permanent protective vegetative cover, most soils must be shaped to a flatter slope. Satisfactory slopes may vary with soil types and often with the same soil in different locations.

Protection of roadside ditches will most often be by mechanical methods on steep grades where high

(Continued on page 11)

Road construction sometimes initiates gullies. Here's a gully in Colorado that is nearly 30 feet deep, becoming steadily shallower toward its source. The culvert in the foreground is 3 feet in diameter, 18 to 20 feet from the bottom of the gully.

REGIONAL CONSERVATORS SPEND BUSY WEEK IN WASHINGTON

"To see where we are going from here", is the way H. H. Bennett, Chief, summarized the purpose of a week's conference of regional soil conservators at its opening in Washington, Monday morning, February 24.

With congressional budget hearings recent history and the national legislative body putting into final order the new Soil Conservation and Domestic Allotment Act, it was deemed of primary importance that Bureau plans and policies be outlined clearly and that national headquarters avail itself of the experience and viewpoint of its 11 principal field lieutenants.

Many Topics Discussed

Every important phase of Bureau activity shuttled back and forth in review at the long council table around which were gathered Dr. T. S. Buie, H. G. Calkins, H. J. Clemmer, J. S. Cutler, H. H. Finnell, L. P. Merrill, Dr. A. L. Patrick, H. E. Reddick, W. A. Rockie, R. E. Uhland, and Dr. N. E. Winters.

Division chiefs, section heads, and specialists joined in the discussions.

Guest Speakers

Speakers included Henry C. Wallace, Secretary of Agriculture; M. L. Wilson, Assistant Secretary of Agriculture; James T. Jardine, Chief of the Office of Experiment Stations; Dr. W. W. Stockberger, Director of the Office of Personnel, and P. L. Gladmon, Chief of the Division of Appointments, Department of Agriculture; F. A. Silcox, Chief of the Forest Service; and Robert Fechner, Director of Emergency Conservation Work.

Attention focussed recurrently on the functions and relationships of regional conservator, State coordinator, and project manager. With many questions yet remaining to be decided by local exigencies, in general it may be said that the conservator will constitute a part of the Washington office, taking from the latter much of its load of responsibility. He will be responsible for inspection, for interpreting Bureau policy in the field, for keeping operations on a high standard, for acting in numerous fiscal matters, and for clearing ideas.

The State coordinator will be the actual State administrative officer, charged with the general direction of project operations. He will be responsible for the development of plans and programs in cooperation with the State advisory committee, and for coordination of the work with cooperative agencies. He will continue as a member of the conservator's staff, but may report on certain matters direct to Washington.

"Primarily, the State coordinator is there to get the job done", said Mr. Bennett, in stressing the importance of having in the position a man of strong executive ability and high standing in the State.

OUTLINE OF DISCUSSIONS[1]

Monday
General organization and functions.

Tuesday
Business administration.
Personnel and training.

Wednesday
Cooperative relations and planning.
Information. Photography.

Thursday
Research in soil conservation.
E. C. W. activities.

Friday
Projects and project operations.

Saturday
P. W. A. activities.

[1] Partial only. This outline does not take into consideration subtopics introduced, committee sessions, and informal group conferences.

Smooth Operation Assured

With this concept of set-up as a starting point, the conferees launched into a full schedule of day and night sessions before which passed in review a long parade of problems in organization, business administration, personnel and training, cooperative relations and planning, informational work, research, E. C. W. and P. W. A. activities, project operations, and fiscal matters. Only a few of the high points may be touched upon in this issue of Soil Conservation. In view of both the com-

(Continued on page 13)

GLEANED FROM MEETING OF REGIONAL CONSERVATORS

One of the keynotes of the conference was the thought expressed by Dr. Lowdermilk, and further developed by Dr. Youngblood, to the effect that our problems are really problems of the Department of Agriculture; that all available facilities and talent of the various bureaus should be utilized to the fullest advantage, and that no single bureau could lay exclusive claim to the results accruing from such coordinated effort.

The readjustment of old projects to a maintenance basis under terms of the new budget was a topic of discussion. Under such readjustment, extension of works to new farms will be curtailed.

To tell the public the facts about activities of its Soil Conservation Service and to tell farmers how they may adapt the methods of erosion control demonstrated by the Bureau is the function of the information staff—not to publicize or propagandize. In making this clear to conservators, George Barnes, head of Information, emphasized the importance of having information workers not only familiar with established channels, but trained in propriety, accuracy, and Service policy and program.

It is highly important that vouchers be audited in the field before being submitted for payment, inasmuch as the certifying officer is personally liable for any overpayment.

When you talk about soil conservation you find that it is almost synonymous with agriculture—Dr. James T. Jardine.

It is necessary to establish terminal facilities so that research studies will come to an end at a definite time rather than continue forever.—Dr. W. C. Lowdermilk.

So far as the details of research are concerned, these are matters of experimental technique, to be worked out by the Service and the States—Dr. James T. Jardine.

A revision of the basic form of cooperative agreement, to permit greater flexibility and ease of adaptation to conditions in the several regions, will result from the efforts of a special committee appointed for the purpose.

Our C. C. C. work was originally started to demonstrate what can be done to conserve trees, soils, wildlife, etc., rather than actually to do the work on an extensive scale.—Robert Fechner.

It is intended that the State advisory committee be limited to not more than five members; usually it will be composed of three: the State director of extension, the State director of experiment station, and the State coordinator. In some instances it will include the dean of agriculture, and, in a few States, it takes in a State forester, a State engineer, or a State commissioner of agriculture. It should be held to representation of agencies or institutions that are directly responsible for administration of programs or projects in fields closely related to conservation.—Dillon S. Myer.

Mr. Myer described the functions of the State advisory committee as being—

To assist in selection of project and camp areas and in policies relating to abandonment of projects or camps.

To assist in development of subject matter, principles, and working plans which are basic for all projects within the State.

To assist in development of cooperative research plans and programs.

To assist in development of cooperative educational plans and procedure.

To assist in formulation of legislation or policies relating to legislation within the State, or to soil conservation districts or associations, or other soil conservation work.

Subcommittees composed of subject-matter specialists in college, working in cooperation with Soil Conservation personnel, are urgently recommended to assist the advisory committee and the Service in development of work plans, project plans, subject-matter principles, and other technical problems and policies.

The advisory committee, says Mr. Myer, should be consulted regarding employment of major personnel, especially State coordinators and major technical men to be assigned to work within the State.

PROGRESSIVE TRAINING PLANNED FOR S. C. S. WORKERS

Within the next few weeks training centers in each of the 11 regions will begin the task of transforming technicians into soil conservationists. Young men whose chief interests heretofore have reposed in agronomy or engineering, forestry or wildlife management, grasses or tractors or test tubes, will be given an opportunity to broaden their outlook, adjust their perspective and prove their usefulness in Soil Conservation Service jobs.

School doors will again swing wide, under a nation-wide program of instruction courses for field staffs announced by Dr. Roy W. Kelly, Chief of Personnel and Training. Studies will be conducted on an intensive scale, supervised by regional personnel officers and training directors, with lectures by specialists, and laboratory work in the form of actual project operations. June 1st has been set as the "dead line" for classes to be underway.

Getting Ready

In Washington slides, charts and other materials are being prepared which will furnish a panoramic view of erosion and its control throughout the country. In the several regions material is being assembled covering the special practices prevailing therein. Each training center will be provided with a carefully selected reference library.

"Regional conservators attending the recent conference in Washington were unanimous in attaching high value to the trainee courses of last summer", says Dr. Kelly. "As a result of the training offered then, there have been many promotions to responsible positions in the field organization. The program now being undertaken comes as a natural development of our explorations of last summer and is in part a result of the round-table discussions of a committee of conservators appointed during the conference."

Training Centers

The training program contemplates early designation of one or two training centers in each region. To these centers will be brought 20 or more picked employees at a time. Appointments will be made from the ranks of specialists in agronomy and range management, soils, agricultural engineering, erosion-control practices, forestry management, and wildlife management.

The class members will be assigned to regular posts of duty on the training-center project where each can do a full day's work in connection with regular field activities, and in some instances will be temporarily replaced at their home stations by transfers of other workers.

Classes will be composed of technical men, mostly of professional or subprofessional grades.

First to be given attention will usually be recently appointed technical employees, who will be put through a 3- to 5-week period of classroom instruction and field work.

Next on the calendar will be 3 months of systematic instruction for students obtained by the Service from civil-service lists in Washington. This will be followed by immediate assignment to active, productive field duty. Including the time taken for the training course, there will be a 6 months' probationary period, upon the successful completion of which will come promotion to positions for which fitness has been proved.

Finally, selections will be made from among the older technical employees, who will be brought together for a week or less of group instruction.

Seminars Probable

Dr. Kelly states that immediately following the completion of the 3 to 5 weeks of instruction for recent technical employees, numerous weekly or biweekly seminars will be organized in which all technical employees will be invited to participate.

The objectives of the training program for students are explained in some detail by Dr. Kelly, as follows:

First, to give to the students a general knowledge of the origin, development, purpose, organization, personnel, and procedure of the Soil Conservation Service. Without such an understanding the employee will be handicapped in many ways, and will never acquire a proper perspective of the organization and his own work. He will lack the general knowledge which is necessary to make him efficient, loyal, and enthusiastic.

Second, to carry on the general or orientation study into the various specialized fields, so that the employee may realize that soil conservation is an organized effort in which are coordinated the efforts of agronomist, engineer, forester, nurseryman, soils expert, and wildlife worker. He will learn by actual field contact how each department contributes in balanced proportion to effective accomplishment. He will become "Service conscious."

(Continued on page 8)

GETTING THE FACTS ON STREAM DAMAGE

At the conference of regional conservators it was brought out that the sedimentation and hydraulic studies concern the far-reaching effects of soil erosion after debris leaves the cultivated uplands and, traveling by way of local drainage, finds its way into major streams.

Accelerated erosion resulting from man's use of the land resources causes this debris to enter the streams in such quantities that in many cases the streams are transporting this load to their full capacity and must continue to do so until they can lay down their burden, either in a lower part of stream bed, over bank on fertile bottom land, in some reservoir, or finally carry it out to sea.

The damage caused by this debris is interfering with navigation, causing floods to rise higher in the valleys, rendering highly fertile land unproductive, and depleting the storage capacity of reservoirs. The amount of this damage cannot even be closely approximated with the present state of knowledge on the subject, but the investments involved must run into billions of dollars.

The problem is being attacked along four main lines.

1. A nation-wide investigation on storage reservoirs, whether for power, irrigation, or water supply, is being made to provide an accurate record of the storage depletion and its effects upon the utility and longevity of the water supply. Information thus gathered will be of great value in determining future usefulness of each reservoir; provide the data for the prediction of depletion in future designs of similar structures, and form the basis for development of methods for temporary reduction of silting rate until widespread erosion control methods can be instituted.

2. Investigations of conditions and processes of sedimentation in stream channels and valleys are being inaugurated. Such studies are of vital importance to the conservation of fertile valley lands from excessive sedimentation and also to the preservation of stream navigability and the reduction of flood hazards.

3. Factors of bedload transportation in natural streams will be studied by direct measurement with new-type installations to be placed at selected sites on various streams in differing regions of the country, for the purpose of obtaining for the first time accurate knowledge of the total erosive and transporting power of large streams under present conditions.

4. Hydraulic laboratory investigations will include studies of factors affecting the energetics of debris-laden water, the wear of debris in the course of stream transportation, specific field construction problems, development of new erosion- and flowage-control practices and instruments for their measurement, and experimental application of results to full-scale engineering problems of gully and arroyo control in the field. These laboratory studies will be made with particular reference to erosion by larger streams, development of arroyos and like problems distinct from erosion studies on experimental plots and controlled watersheds.

TRAINING PLANNED

(*Continued from page 7*)

Third, to provide job training in the specialized work for which the student enrolled. During this period of specialized work those in charge can discover the potential value of the new employee in his chosen field.

Fourth, to absorb the new employee into his permanent job on a probationary basis. During the entire probationary period he will be considered not only under observation but under instruction. If during the probationary period he lives up to the expectations of his superior he becomes eligible for permanent appointment and is then considered a regular employee fully qualified to proceed under his own initiative.

During the first year of service, new employees who come in as students will pass through four periods, the first three of which will constitute their training period, and the fourth of which will round out their 12 months' probation. As the end of the first week of classwork, the students will be divided into four, five, or six groups, according to their professional classification. Each group will be routed through a series of five stations on the training-center project or a neighboring project which will give practical training in soils, agronomy, engineering, etc., corresponding to the groups into which the class has been divided. One week will be spent at each station, and at the end of the period of station work each group will find itself assigned to the station representing its own professional classification. All groups will arrive at their own professional stations simultaneously.

The next 6 weeks will be given over to intensive specialized training, during which studies rather than production will have right-of-way.

It is the intention of Dr. Kelly and his collaborators that the entire training program shall be flexible and readily adaptable to local conditions.

RESEARCH IN THE ECONOMIC AND RURAL LIFE ASPECTS OF SOIL CONSERVATION

By Walter J. Roth[1]

Author's Note.—The following article was prepared in answer to numerous inquiries concerning the functions of the newly organized division of research in the economic and rural life aspects of soil conservation and its relations to other parts of the Service.

People themselves, their environment, their farming philosophies, their business and community relationships, color the foreground of the soil conservation picture. If our understanding of erosion and its control is to be in proper perspective, we must give weight to the economic and social factors. Excellent facilities already exist in the Department of Agriculture, as a basis for the specialized studies we contemplate, and this paper sketches roughly the lines of this phase of our research program.

In accordance with the principles set forth in the Secretary's memorandum of June 6, 1935, and the interbureau committee report of June 5, 1935, suggesting ways and means whereby all branches of the Department of Agriculture and the State agricultural experiment stations may participate in a comprehensive program of soil conservation research, a memorandum of understanding has been entered into between the Bureau of Agricultural Economics and the Soil Conservation Service. This memorandum assures the Soil Conservation Service of the leadership and experience of the Bureau of Agricultural Economics in research upon the economic and rural life aspects of its work. The objective is to provide sound economic and social research, as a basis for the development of policy and program.

The Memorandum of Understanding

In addition to recognizing the Bureau of Agricultural Economics as the agency directly charged with conducting research in the economic and rural life aspects of agriculture, and setting forth the need of such research by the Soil Conservation Service, the memorandum states that the Soil Conservation Service shall provide for such economic and rural life research as may be required in cooperation with the Bureau of Agricultural Economics.

The memorandum further provides that specialists approved by the Bureau of Agricultural Economics will be employed by the Soil Conservation Service to conduct, under the direction of a liaison officer, the essential research in the economic and social aspects of soil conservation. While this personnel is administratively responsible to the Soil Conservation Service, the Bureau of Agricultural Economics retains the authority for approval of projects, supervision of procedure, interpretation of data, and validity of conclusions. To the greatest extent possible, all such research activities of the Soil Conservation Service will be coordinated with the other research activities of the Bureau of Agricultural Economics.

One of the paragraphs specifying the activities of the newly developed economic research division is worthy of quotation:

> (e) The Soil Conservation Service may make economic surveys of farms in order to secure information for the conduct of its soil conservation operations, but will engage in no independent economic research. Such surveys in the future shall be organized so as to furnish information for the economic and rural life research. For this purpose the liaison officer shall approve all proposed survey schedules and the procedure for collection of the information. Workers of the Division of Conservation Operations who have participated in the conduct of these surveys of farms may be assigned to the economic research staff for the purpose of assisting in the research analysis when, by mutual consent, it is deemed of value to do so.

The foregoing statement means simply this: The Soil Conservation Service, in cooperation with and under the guidance of the Bureau of Agricultural Economics, will conduct research in the economic and social aspects of soil conservation, through the medium of the cooperative relations now in existence between the Bureau of Agricultural Economics and the State agricultural experiment stations, where such cooperative effort is mutually acceptable.

Cooperation with Experiment Stations

The Bureau of Agricultural Economics has had much valuable experience in the development and conduct of cooperative projects in all the States. This experience includes projects which involve a combined attack by State and Bureau workers on a multitude of problems. These are especially well exemplified by those in the organization and operation

[1] Dr. Roth is liaison officer and head of the division of research in the economic and rural life aspects of soil conservation.

of farms and related topics conducted by the Division of Farm Management. An outstanding example of such constructive cooperation was the conduct, under the guidance of the Division of Farm Management, of a significant research project in the summer of 1935. In cooperation with the A. A. A. and the 48 State agricultural experiment stations, the essential information relative to the suggested adjustments in the agriculture of the States was synthesized into a major statement for the agriculture of the Nation. This master project was continued in the autumn and winter of 1935–36 for further refinement and for verification of the initial judgments.

It was felt that the many worth-while contacts which have made such cooperation possible could be expanded to include the proposed research in the economics of soil conservation, much of which would be akin to the regular activities of the Division of Farm Management of the Bureau of Agricultural Economics. In furtherence of this idea, Farm Management furnished a member of its staff to serve as liaison officer between the Soil Conservation Service and the Bureau of Agricultural Economics, and to head the new research division.

With the plan now complete, administrative details are rapidly being worked out and proposals for a cooperative attack upon the economic and rural life problems incident to soil conservation will soon be ready for submission to the State agricultural experiment stations.

Cooperation with Division of Operations

Cooperation will be forthcoming from the Division of Operations of the Soil Conservation Service. Realizing early the need of research of this character, this division instituted a number of studies, the character of which permits of their being classed as economic research. According to the memorandum of understanding, these studies will be absorbed by the newly organized economic research unit. Because of the obvious value of such studies to the Division of Operations and because the members of the operations staff can make a major contribution to the collection, summarization, and analysis of economic and social data, the memorandum of understanding has provided that members of the Division of Operations may be assigned to active participation in these economic studies. Thus, instead of absorbing these studies, as such, the research division will function cooperatively with the operations division, and both, under the guidance of the Bureau of Agricultural Economics, will work toward a single purpose.

While cooperation between the research and operations divisions is in no sense rigidly fixed or mandatory, it does offer an opportunity to accomplish a larger portion of the purposes envisioned in the program for soil conservation than would otherwise be possible. The budget available for economic and social research will effect larger results by such cooperative effort. The details of this intra-bureau relationship will of necessity be a matter of arrangement with each regional conservator and finally with each State coordinator and project manager. In regions, States, and project areas where adequate cooperative assistance is available from the Division of Operations, the attack upon the problems will be proportionately larger.

Joint Effort Helpful

This joint effort will prove mutually beneficial. The data can be collected by a personnel thoroughly familiar with the farms being studied and benefitting from the guidance of trained research specialists. The summarization and analyses of the data, also participated in by representatives of the Division of Operations, will offer a maximum opportunity to produce valid conclusions. Under such a joint effort, many soil conservation problems will receive immediate as well as long-range solution.

In final analysis, all activities of the Soil Conservation Service may be challenged with the query: Are they economically and socially justifiable? Will they yield a dividend not only to the farmer but to society as well? In short, Will they pay?

It is a truism that the benefits of the observations developed in the operations activities will contribute materially to the interpretation made by the trained analyst. The point of view of the latter will likewise sharpen the observations of the workers more definitely confined to operations. The active cooperation of the operations staff with the research staff of the Soil Conservation Service, and of both with the specialists in the agricultural experiment stations, will mean a greater degree of usefulness for the research findings than if these were developed solely by the research staff.

As previously said, the objective is to provide sound economic and social research for the activities of the Soil Conservation Service.

Simply stated, such studies will be concerned with a contrast of the economic and social effects of uncon-

trolled and progressive erosion and soil depletion on the one hand, and the economic and social effects of soil-conservation measures on the other.

This means:

1. A study of economic and social conditions before the installation of erosion-control measures;

2. A forward-looking estimate of the economic and social effects likely to result from the inauguration of a definitely planned program of erosion control;

3. Eventually a backward-looking evaluation of the economic and social effects which have resulted from the adoption of the recommended measures; and, finally,

4. Such additional studies as will ultimately provide the Soil Conservation Service with a sound economic and social evaluation of the problems involved in its activities.

These studies will be concerned with both individual farms and with groups of farms. Through a process of extension of the findings, they will in time have an important bearing in planning the soil-conservation program of the entire Nation.

Out of these economic studies will come answers to many questions, such as the effect of the inauguration of soil-conservation measures upon farm practices, upon the organization and operation of the farm, upon farm income, and, finally, upon the farm-family living. Out of the studies will come evidence of the economic and social effects of erosion control upon groups of farms, communities, counties, or States and, indeed, upon the entire economic and social structure.

This is the proper field of inquiry. We believe that it will enable the division of research in the economic and rural-life aspects of soil conservation, in cooperation with the Bureau of Agricultural Economics and the State agricultural-experiment stations, to serve the Soil Conservation Service in the capacity envisioned—that of providing a sound, economic, and social evaluation of all its activities.

EROSION ALONG HIGHWAYS

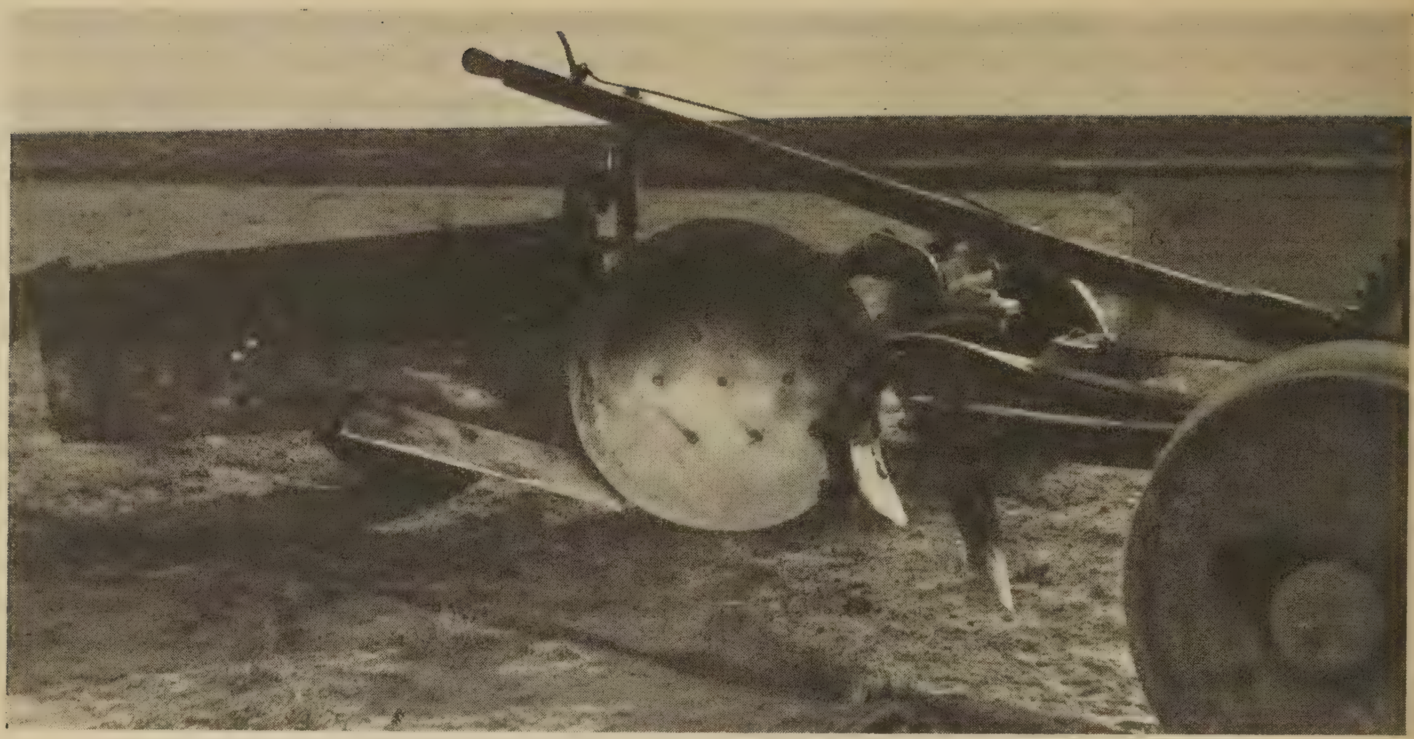
(Continued from page 4)

velocities cannot be prevented. On flatter grades wide, shallow, low-velocity ditches may be protected by vegetation. Types of vegetation adaptable to the soil and climate and its ability to prevent scour under various velocities must be tested and demonstrated. The cost of widening cuts to provide additional ditch width will often be prohibitive and mechanical control in the ditches will be necessary where otherwise less expensive vegetative control would have sufficed.

Realize Responsibility

Protection of erosion in cross-drainage channels has not always been considered a responsibility of the highway official unless the highway itself was damaged. The fact that concentration of waters by the highway often damages lands below the road or the fact that concentrated waters are discharged across lands at new locations, does, however, indicate the need of highway authorities giving greater attention to erosion. Control of overfall gullies cutting headward above highways caused by overfall developed at cut banks, drainage structures, or other places for which the highway is accountable, is also within the sphere of those engaged in highway construction and maintenance.

The ultimate objective should contemplate the adoption of effective erosion-control measures on existing highways and inclusion of them in plans for future highways. In fact, by far the greatest good can be accomplished with the least expenditure by providing for erosion control and roadside beautification at the time the highway is first planned. A great many factors should be considered by the locater and designer that have not always been given proper attention in the past. Location of highways with consideration for future erosion control and beautification would result ordinarily in improvements of other kinds. Maintenance would surely be lessened by reduction in scouring and silting. There would be fewer slides, falling rocks, washouts, caged fills, and less silt would be deposited on adjoining lands. The locating engineer, instead of attempting only to fit the required alinement and gradients to existing topography in the most economical manner possible, so far as initial costs are concerned, would give some thought to such factors as soils, soil moisture, underground drainage and seepage, exposure, general topography as it relates to drainage, possibilities of drainage water entering and leaving the roadway without damage to the highway or adjoining lands, and probabilities of slumps and slides. To secure really effective erosion control for future highways, the type of roadside should receive full consideration.



New contour furrowing plow developed by soil conservation technicians at C. C. C. camp, Springfield, Colo.

PROTECTING COLORADO'S RANGE LANDS

By J. G. Lindley [1]

Colorado is a State of high plains and redbeds, of Douglas fir and Englemann spruce, of Russian thistle and grama. Its topography ranges from the towering Sawatch Mountains to the comparatively low Arkansas River Basin.

Agricultural regions within the State necessarily present a similar variety. Colorado leads in the production of sugar beets. It stands high in cantaloups, fruit, potatoes, and barley. And—here's where Colorado soil conservationists find a real problem—the 1930 census gives a total of 19,338,377 acres of pasture land, much of which is rapidly becoming depleted by overgrazing and subsequent wind and water erosion.

A Difficult Situation

When the Soil Conservation Service inaugurated its erosion-control program for the State in March, 1935, overgrazing and a succession of dry years had reduced vegetation on thousands of acres of pasture lands to a sparse stand of grass and stunted Russian thistles. Slopes range from 1 to 7 percent, and the dusty condition of the surface made water penetration negligible. Run-off during the torrential rains, which are characteristic of this region, amounted to as much as 90 percent. Sheet erosion, gully cutting, and destructive flood-water concentration were the result.

The soil-conservation demonstration work was augmented by the establishment of nine Civilian Conservation Corps camps. Two of these were transferred from the Forest Service—the one near Colorado Springs where an effort was being made to control floods coming into the city down Shooks Run, and the one at Castle Rock where the project embraced several of the main tributaries of troublesome Cheery Creek. Seven new C. C. C. camps under the expanded program were distributed in eastern Colorado from Box Elder Creek in the redbeds to Springfield, well within the northern limits of the dust bowl.

Previous experiments had shown that effective control might be achieved only by holding the water on the ground where it fell. This strategy results in retarding concentration, stopping sheet and gully erosion, furnishing moisture to reestablish a vegetative cover, and eventually raising the water table.

Contour Ditches Built

A. E. McClymonds, regional director, since designated State coordinator, found the answer to those

[1] The author of this article is head of E. C. W. operations of the Soil Conservation Service.

objectives in contour ditches large enough and close enough together to retain all of the water which might fall during any one storm. Insufficient precipitation statistics were available for computation of the necessary cross-section sizes and contour intervals. Using an arbitrary basis of 3 inches of rain as the maximum, contour furrows were constructed 8 inches deep, 10 inches wide at the bottom, and 20 inches wide at the surface. These furrows were constructed at 2-foot vertical intervals, the dirt from each furrow being used to form a dike on the lower side. The upper toe of the dike was set back 6 inches from the lower rim of the ditch so that the shoulder formed a berm to prevent the sloping earth of the dike from falling into the ditch. Cross-checks are built every 50 feet along the contour ditches.

During the first experimental work, a plow furrow was made on the contour and enrollee hand labor followed with shovels and mattocks. This method was too slow, and camp superintendents were encouraged to try out different plows and ideas to speed the task.

As a result of their ingenuity, two plows were developed, which are different from anything used before and which are admirably suited to do a finished job in one operation. C. C. C. enrollee labor is now used only to install the cross-checks and to do a very small amount of finishing work in the furrows and dikes. By this method it is possible to turn out 6 to 8 miles of contour furrows per day, per machine, and it is believed one of the problems of protecting Colorado's range lands has been solved.

Efficiency Reported

Do the contour furrows hold the water and conserve the soil? Colorado's C. C. C. camps report that they do. The Pueblo camp received two heavy cloudbursts during the latter part of August. In the first a little less than 2 inches of rain fell in 45 minutes; in the second, 2 inches of rain fell in 60 minutes.

Two interesting results showed up following the last big rainfall. Sixty hours after the storm it was found that in the contour furrows the moisture had penetrated to a depth of 41 inches. Half-way between the furrows, moisture had penetrated to a depth of 24 inches, whereas on land located in the same field and on the same slope, but upon which contour furrows had not yet been constructed, the moisture had penetrated to a depth of only 8 inches. The other notable result of the two storms was the rapid growth of grass during September on the land which had been contour furrowed. There was a decided difference in the brightness and growth of grass on the land which had been treated, compared with adjacent untreated fields. By October, the grass along the upper sides of the contour furrows was in bloom and starting to form seed—the only grass seed formed on any land in that part of the Pueblo area during the year.

Good Results Attained

This report from the Pueblo camp is not an isolated one. Each C. C. C. camp reported similar success. Only in a few instances did a dyke break, and then, contrary to expectations, it did not result in progressive failure down through the lower contours. For the first time known, all of the water was held on the ground. Not a drop ran away to the gullies, and for 2 days glistening parallel ribbons of water stretched over the undulating hills, slowly penetrating the thirsty ground.

But contour furrowing is not the only C. C. C. erosion-control activity in Colorado. Trees are being planted to combat the menace of wind erosion. Check dams are protecting both agricultural and grazing lands from gullies and from floods. Seed collection, riprapping, stream-bed improvement, bank sloping—these are all units in the balanced soil and water-conservation program now going forward under full steam.

Many problems still confront the Soil Conservation Service and its nine C. C. C. camps in the State, among them the exclusion of stock from range lands while revegetation is under way, and proper methods of reseeding. An entirely gratifying result of the program is the reaction of the farmer. Colorado farmers are becoming convinced that many of their worries will be solved under this new land treatment.

REGIONAL CONSERVATORS

(Continued from page 5)

prehensive and intensive study of objectives and of *modus operandi*, conservators are assured of increased smoothness and sureness of practice and procedure in their several regions henceforth. This conference, the first of its kind, will be followed by others—probably at 4-month intervals through the year.

As the conference came to a close, the new Soil Conservation and Domestic Allotment Act became law and Secretary Wallace announced meetings for Chicago, Memphis, New York, and Salt Lake City to consider its implications. Conservators, in many cases, went direct to these meetings from Washington, to lend any assistance possible in making the new program a success.

A NEW MACHINE FOR MAKING CONTOUR FURROWS

By C. A. Logan

EDITOR'S NOTE.—This article presents more detailed information concerning the machine described on page 16 of the October 1935 number of this magazine.

The need for a less expensive and better method of contour furrowing pastures in the Limestone Creek demonstrational area in Kansas was the incentive for developing a new machine.

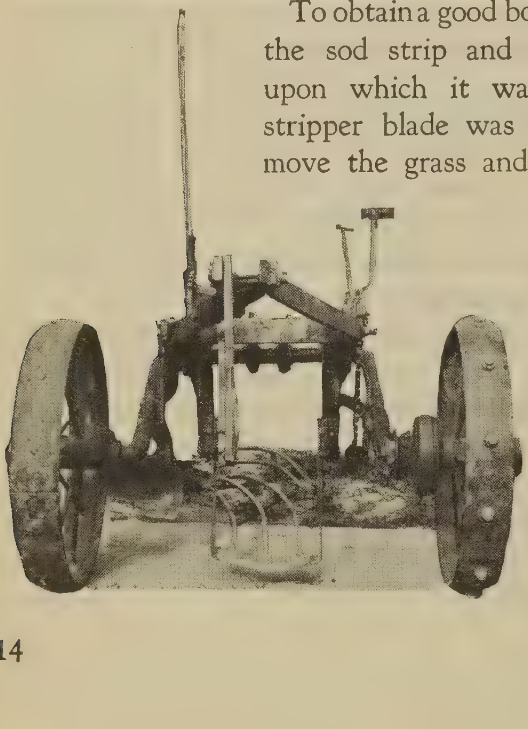
The idea of placing a sod strip in an unbroken ribbon on the lower side of a furrow, with the grass side up, looked so promising that when hand labor proved impracticable a determined effort was made to build a machine that would do the job.

The one-way and two-way machines shown in the illustrations were designed and built by A. J. McCleery, H. L. Gamble, and myself.

The first machine was made from a worn-out two-bottom plow; an old road planer blade; ⅝-inch round mild steel rods, and 1¼- by 1¼-inch angle iron. A satisfactory hitch, depth regulating lever, stripper blade and the proper curvature and length of rods had to be worked out by trial and error.

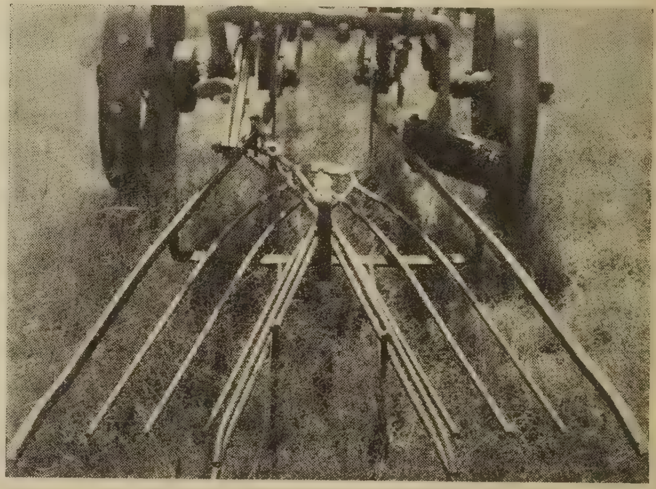
Occasional trouble was experienced when tough weeds and roots collected on the vertical cutting edges of the U-shaped blade. This condition was most noticeable in loose, moist soil and was largely overcome by sloping the vertical cutting edges forward at approximately 35°.

To obtain a good bond between the sod strip and the ground upon which it was placed a stripper blade was used to remove the grass and trash. To keep trash from clogging under the cutting edge the toe of this blade was adjusted to about three-fourths of an inch deep when the heel was just entering the ground.



Sod strip properly placed 3 to 4 inches below furrow wall.

Rear view of two-way contour furrowing machine. It may be reversed by pulling a pin and reversing center segment of rods.



The unit can be pulled by a 1½-ton truck but a two-plow tractor is preferable. By careful driving, horses or mules could be used.

The rapidity of travel affects the placing of the sod strip. A properly placed strip should be 3 to 4 inches below the furrow wall to lessen the possibility of breaking down the side wall and the narrow strip of grass left growing along the edge aids in making a water-resistant seal. When using power units of different speeds it is necessary to adjust the curvature of the delivery rods to secure proper placement of the strip.

(Continued on page 15)

CORN GIVES WAY TO DIVERSIFICATION

By R. E. Uhland

The one-crop system of farming which existed in the Big Creek area of Missouri up to the establishment of the Soil Conservation Service project there in October 1933 is rapidly giving way to crop rotations and diversification.

Corn had been considered king for many years and it was with reluctance that some of the farmers changed from all corn to less corn and a variety of other crops. On many farms this change should have been made many years ago, as soil losses have brought about a state of infertility which it will take years of planning and effort to restore to anything near their original productivity.

Our soils men have found that 50 to 75 percent of the surface soil is gone on more than half of this watershed. Along the interstream divides where Grundy was formerly wide and fertile it is now thinned a great deal and the strip along the ridge is much narrower. Comparing this condition with a soils map made 20 year ago reveals the startling change that has taken place. Depletion proceeded so gradually that people living on the soil hardly realized what was happening.

There are 1,042 farms in the 152,217 acres comprising the Big Creek Watershed. Most of them are now covered by cooperative agreements with the Soil Conservation Service. Many of the operators are going ahead with the program, under the guidance of the field men of the Service, quite on their own initiative. Recently a number of farmers asked that strip crops and contour crops be laid out on their farms, even though their original agreement did not include these measures. In most cases farmers asking to have strip cropping or contour farming added to their agreement live close to a neighbor who has one or both of these practices on his farm. They have observed the part strip crops or contour rows play in solving the problem of soil erosion, and also how easily they work with terraces.

Prior to starting the project, contour and strip cropping were practically unknown in this area. At first many farmers viewed the practice skeptically. Farmers of the region have always taken pride in making straight rows and many of them felt to run their rows on the contour would take all the pleasure out of their work. That this fear is being dispelled is shown by the fact that 4,238 acres will be newly strip cropped and 6,189 acres will be newly contour tilled. These practices are of course supplementary to the changes in cropping plans and terracing.

Probably the most remarkable change of all, however, is the general willingness on the part of owners and tenants to change from corn to a diversification and a crop-rotation system which will include a legume at least 1 year in 4. Crop rotations have been worked out for 46,386 acres of land; 12,699 acres of erosive land have been taken out of cultivation and seeded to permanent hay and pasture. Pasture management is being stressed for the entire area. In some cases this adoption of the recommended rotations and cultural practices may mean a slight reduction in income for the next year or two. Our farmers see the advantage of making a temporary sacrifice in favor of a good soil-building program.

NEW MACHINE

(Continued from page 14)

The two-way or reversible unit is desirable where the furrows are longer than 600 feet. One disadvantage of the two-way machine is the fact that the sod must be removed from the rods before the movable guide can be reversed. It is possible that in large-scale operation it would be more economical to have independent right and left units mounted on one frame.

Data from experimental plots on the Limestone Creek area show that the contour furrows increased the forage growth about 29 percent in 1935 and that the best horizontal spacing between furrows was from 16 to 20 feet. Furrows were 12 inches and from 4 to 6 inches deep. More experimental work is necessary to determine the best width and depth.

This method of treatment is particularly well adapted to buffalo sod pastures where the sod is sufficiently dense to form a continuous ribbon.

How a sod strip with a good seal impounds water.

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

A Contribution from the Soil Conservation Service Library

SAHARA, THE GREAT DESERT. By E. F. Gautier. Translated from the second French edition of Gautier's Le Sahara. Translation by Dorothy Ford Mayhew. 1935.

This is a book for the geographer and geologist, with copious notes regarding the author's researches and the results of his and other expeditions into that vast expanse of land which breaks all records as a planetary desert—the Sahara. Through part I, Gautier contrasts and differentiates between the steppes and the true desert. This appears to the reviewer to be an especially brilliant maneuver, separating and emphasizing as it does in the mind of the reader the vast, almost completely azoic belt which is the Sahara proper, from the Continent of Africa and the whole planet Earth, in preparation for the learned study of the geological and geographical structure and history which is the body of the book.

According to Gautier, there is a considerable amount of precise and conclusive data supporting the theory that at an age as remote as the Silurian the Sahara was already a desert. Some other writers, however, who have studied the desert, present evidence to the effect that, although arid, parts of the Sahara were grassed at the time camels came into the region, and that the Romans bought wine from coastal areas.

In the still unknown heart of the Great Desert, where the sedimentary deposits are concealed by the erg, a great deal of geological investigation must be done before the remote history of the region can be known. However, much work has been accomplished by the Algerian Geological Service in the northern region and on the Algerian steppes. There are found incrustations of alluvial secretions, layer upon layer, in Oligocene and Quaternary strata, containing fossils by which both their age and continental origin are established. It appears that, in the Triassic stage, Algeria was a composite of closed basins, with lagoons where salt and gypsum were deposited in extraordinary quantities. Likewise, the sandstone layers, laid down through different geologic ages, are similar in that they are all petrified, solidified ergs. From this it is concluded that, generally speaking, the Algerian climate changed little from the Silurian age to the glacial age when there was more humidity than at the present day.

It was in the glacial age that vast, complex valleys were cut, from the Atlas to the bend of the Niger, and in the French Sahara. Great rivers were there, and today their courses are easily distinguishable between great ergs and denuded rock mountains. These Quaternary rivers, terminating in closed basins or alluvial regions such as Lake Chad today, formed a communication route between the Mediterranean regions and the Sudan, as the Zambezi fauna fossils found in Saharan Quaternary deposits attest. The Carthagenian elephant, mentioned by ancient historians, is, indubitably, a relic of this residual fauna. It would be interesting to know what was the distribution of this elephant. Its existence suggests vegetation, and a decline of vegetation during the historical period. If such a decline, erosion should have been accelerated within the historical period, at least in parts of the Sahara.

The author's story of superficial circulation of Saharan water is extensive and detailed. Points that are of outstanding interest are: The subterranean infiltration of the Niger waters far out under the great Juf wasteland; "elbow capture" in the making today—where a Niger tributary captures a Shari tributary during flood seasons; the mysterious buried channel of the Shari. One cannot but wonder what will become of the vast underground reserve waters of the Chad Netherlands when, in an age to come, the Niger system completely conquers the Shari system. Will it be diminished gradually, poured into the Gulf of Guinea 2,000 miles to the west?

The triumph of the Nile in traversing the entire desert and finally reaching the sea, by way of the Quaternary Rift Valley, is unique in the known history of the desert rivers. Here is the one route by which the abundant waters from the great Abyssinian mountains are carried through the Sahara northward to the sea. The Saura system, however, originating in the high Algerian plateau, occasionally is flooded by terrific mountain-storm waters so that, rushing with tidal-wave force down the steep slopes, it carries an immense amount of water southward to the great dune land of the Algerian desert, there to end in an alluvial region, to seep through erg sand and join the subterranean system of the ancient Saura. Here, along the Saura, lie true oases, with palm groves and villages, and here with the onslaught of the yearly or biyearly floods, unwary travelers camping in the dry channels are sometimes drowned before they have any thought of rains or floods.

The study of progressive desiccation of the Sahara, as presented by Gautier, is extremely interesting. From well-authenticated historical data collected by various Tunisian department of agriculture scientists, and by the botanist, Lavauden, it appears that the Sahara, along its northern front was, as late as the fifth century B. C., associated with a civilized humanity. Archeological investigations prove that in the Terres Sialines region the Romans carried on extensive agricultural pursuits. In the same region today, under the direction of Bourde of the Tunisian department of agriculture, excellent olive crops are produced. This fact does not seem compatible with any real climatic deterioration since the Roman epoch. Possibly erosion was the cause of the rapid land desiccation between the Roman epoch and the present day—over use of the land and waste of the springs of water.

In his description and discussion of desert erosion cycles, Gautier is a little disappointing. If, as he sets forth, the words "wadi" (a desert watercourse ending in an alluvial region in a closed basin) and "pasturage" are interchangeable in the language of the nomads, must not there have been in the present geologic age, a period of accelerated erosion resulting from over use? In fact, in the author's air photograph of a *daya* plateau, surface erosion is actually to be seen.

As to the Saharan oases, they have their life and being, not in the superficial or surface waters, but in the artesian waters which flow in great beds beneath the rocky foundational layers and are brought to the surface only through the occasional play of a fault or rift in the crust. Thus it is that the oases are small and few in number. Contrasted with these tiny fertile areas, are the vast completely arid regions called by the author "tanezroufts", the utterly old desert, the empty dead immensities where, according to the superstitious nomads, a jinn called Rul bursts into laughter and shouts from the dunes.

In striking contrast with this prehistoric and historic Sahara, Gautier has, in his conclusion, presented a vivid picture of North Africa's vast arid lands during the last 75 years of European occupation. This conclusion he calls "The New Sahara", and in it he tells of an open country already confronted by economic and industrial problems common to modern progress, yet showing an amazing advance and development in an incredibly short space of time. Modern transportation, the wireless telegraph, beacons as guides to motor as well as air travel, intensive cultivation of cotton and gum acacias and manufacture of gum arabic along the Nile, the opening of river routes from the Chad Basin, the establishment of fisheries at Port-Etienne with the European and Black African coastal markets, the suppression of the slave trade—all these Gautier regards as the beginning of a new and happy era for the Great Saharan Desert.

"Sahara, the Great Desert", is specially well assembled, with fine photographs, drawings, and maps by Paul Laune, a glossary of Saharan words and expressions, and complete index. There are bibliographies at the ends of all chapters.

U. S. GOVERNMENT PRINTING OFFICE: 1936

PUBLICATIONS ON VARIOUS PHASES OF WILDLIFE CONSERVATION

Compiled by Etta G. Rogers, Publications Unit

Field offices of the Service should follow the procedure outlined in Field Memorandum SCS-218 for ordering publications. Others should address the office of issue.

Soil Conservation Service

Wildlife and Erosion Control. Address. H. H. Bennett. 1935.

A New but Major Force in the Field of Conservation. Address. H. H. Bennett. 1935.

Wildlife Management by the Soil Conservation Service. Address. E. G. Holt. 1936.

Wildlife Conservation Plan for Pennsylvania. Paper. W. R. Van Dersal. 1936.

How Valuable is Wildlife on the Farm? Paper. P. F. Allan. Ithaca, N. Y. 1936.

U. S. Department of Agriculture

Some Common Game, Aquatic, and Rapacious Birds in Relation to Man. Farmers' Bulletin No. 497.

Food of Some Well-Known Birds of Forest, Farm, and Garden. Farmers' Bulletin No. 506.

Economic Value of North American Skunks. Farmers' Bulletin No. 587.

Some Common Birds Useful to the Farmer. Farmers' Bulletin No. 630.

Cottontail Rabbits in Relation to Trees and Farm Crops. Farmers' Bulletin No. 702.

Common Birds of the Southeastern United States in Relation to Agriculture. Farmers' Bulletin No. 755.

How to Attract Birds in the Northwestern United States. Farmers' Bulletin No. 760.

How to Attract Birds in the Middle Atlantic States. Farmers' Bulletin No. 844.

How to Attract Birds in the Eastern Central States. Farmers' Bulletin No. 912.

Crow in Its Relation to Agriculture. Farmers' Bulletin No. 1102.

Homes for Birds. Farmers' Bulletin No. 1456.

Propagation of Aquatic Game Birds. Farmers' Bulletin No. 1612.

Propagation of Upland Game Birds. Farmers' Bulletin No. 1613.

Local Bird Refuges. Farmers' Bulletin No. 1644.

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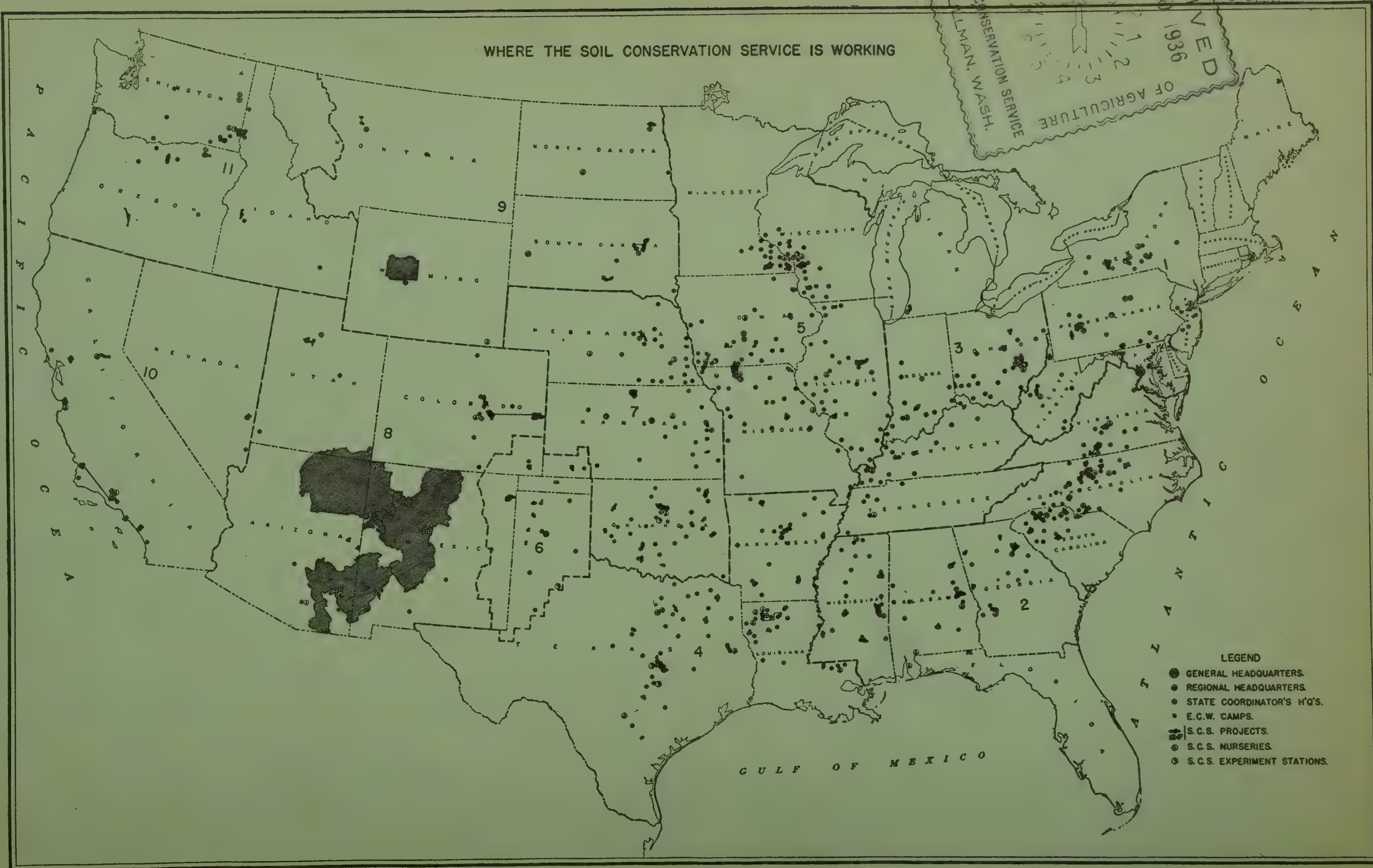

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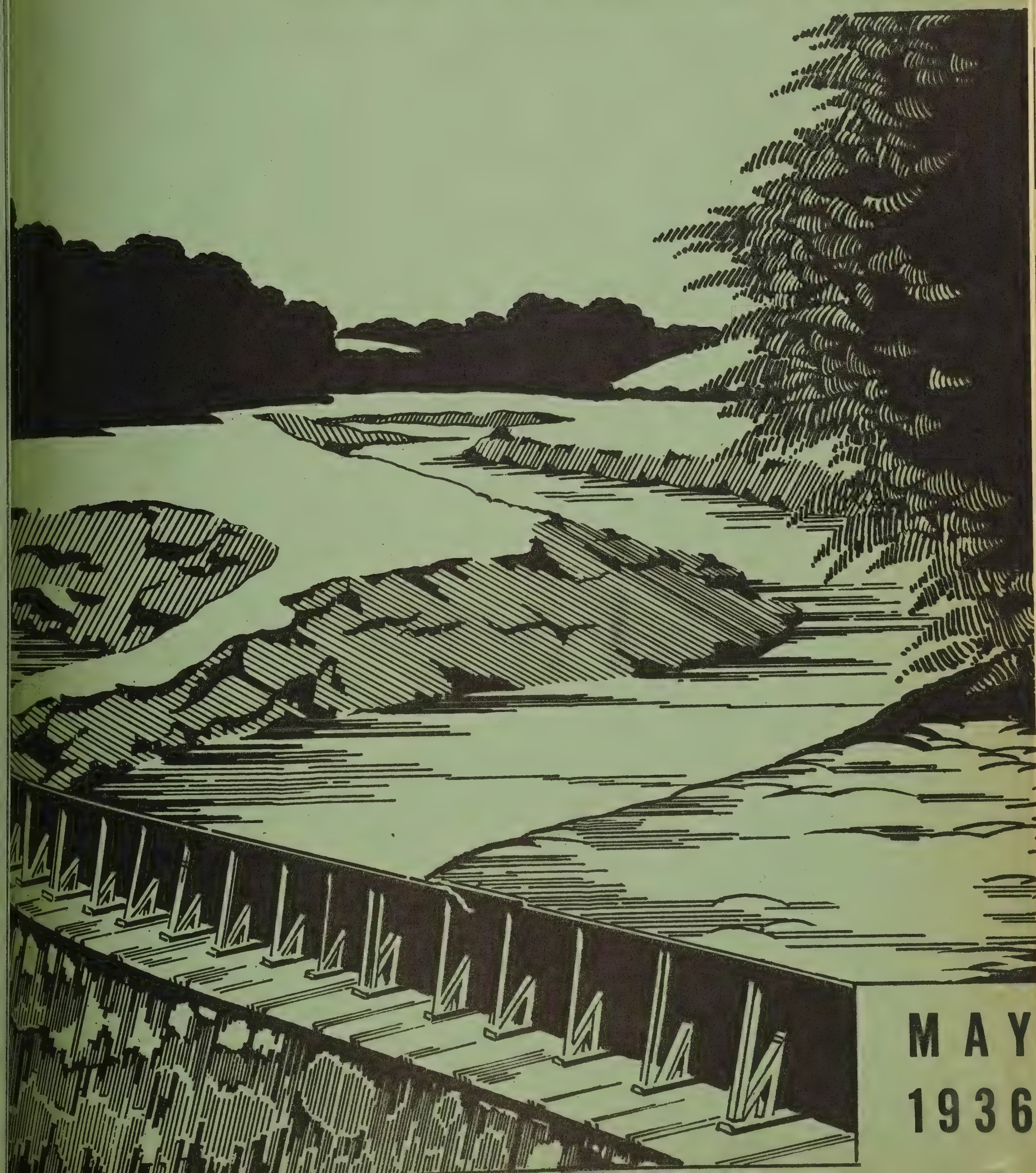

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Soil Conservation is issued monthly by Soil Conservation Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Soil Conservation seeks to supply to workers and cooperators of the Department of Agriculture engaged in soil conservation activities, information of especial help to them in the performance of their duties, and is issued to them free by law. Others may obtain copies from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of $1.00 per year, domestic. Postage stamps will not be accepted in payment.

WELLINGTON BRINK — EDITOR

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HENRY A. WALLACE
Secretary of Agriculture

H. H. BENNETT
Chief, Soil Conservation Service

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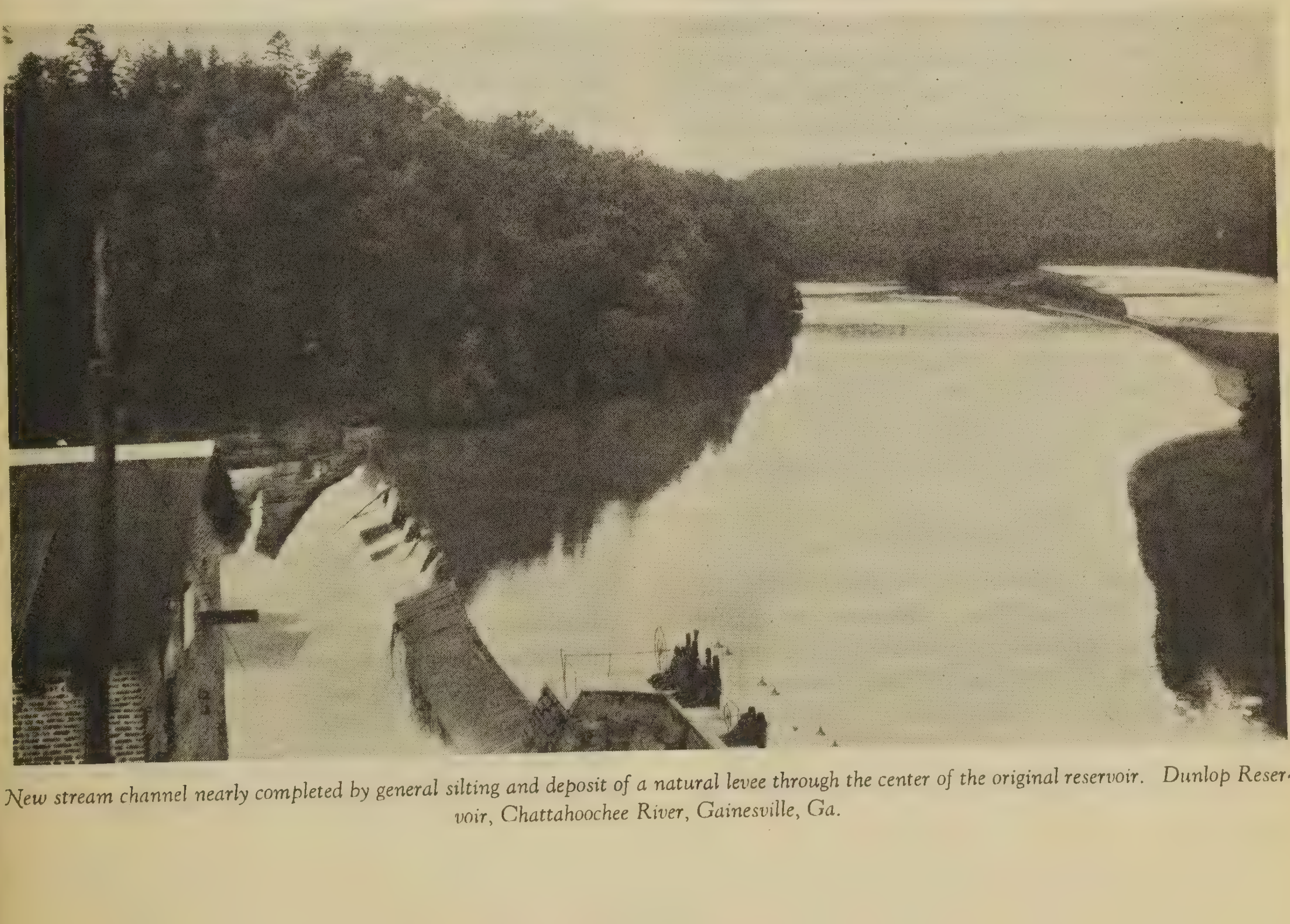
STUDIES OF RESERVOIR SILTING

By Carl B. Brown[1]

Elk City, Okla., constructed a water-supply reservoir in 1925 at a cost of $325,093. After 6 years' use, excessive silting made it necessary to raise the spillway 2 feet to provide adequate storage. In August 1935 the lake was estimated to have lost 48 percent of its original capacity from silting. This reservoir is the second which Elk City has had, the first having silted up at the time the present lake was built. With a 48-percent capacity loss in the present lake, the city is already making plans for constructing a new dam, the water supply now available being insufficient for municipal needs. The watershed

[1] The author is project leader for reservoir investigations, sedimentation, and hydraulic studies, Division of Research, Soil Conservation Service.



New stream channel nearly completed by general silting and deposit of a natural levee through the center of the original reservoir. Dunlop Reservoir, Chattahoochee River, Gainesville, Ga.

above the present reservoir is over 85 percent in cultivation.

Old Lake Austin on the Colorado River at Austin, Tex., was completed in 1893 with a capacity of 18 billion gallons at a cost of $1,400,000. In the 6.75 years until April 7, 1900, when the dam was washed out by flood, the reservoir had lost 48 percent of its capacity by silting. This figure converted into direct economic loss on the capital invested is equivalent to $93,000 per year. In 1913 a new dam was constructed at Austin which impounded a reservoir of 10.5 billion gallons. A survey made in 1926 showed that silt had displaced more than 95 percent of the original water storage capacity of the new lake in the space of 13 years.

Diminishing Capacity

Waco, Tex., completed in 1930 a storage reservoir which, together with appurtenant water-supply developments, cost about $7,000,000. A survey by the Soil Conservation Service in 1935 showed that the reservoir had filled 12.38 percent with silt, or at the rate of 2.48 percent a year. Unless steps are taken to reduce this exorbitant rate of filling, the storage capacity will be entirely exhausted in another 35 years.

Zuni Reservoir, on the Zuni River at Blackrock, N. Mex., lost 76.5 percent of its capacity between 1907 when the dam was completed and July 1932. The rapidity with which storage was being lost became so serious by 1923 that protective works to hold the silt on the watershed were begun that year on Rio de Los Nutrias, the principal silt-producing tributary. In July 1931 a hole was blasted in the gate tower for installation of a 4- by 6-foot sluice gate, which was completed on October 15, 1931. In the 3-month interval it was possible to sluice out of the reservoir only about 500 acre-feet of a total of 11,960 which had been deposited. Sluicing operations have continued each year whenever water was available, but without materially adding to the available storage space.

Survey Shows Loss

Elephant Butte Reservoir on the Rio Grande, 120 miles above El Paso, Tex., supports an agricultural development having an estimated value of more than $100,000,000. Without the stored water available for irrigation in this reservoir probably nine-tenths of this wealth would disappear. A survey of the reservoir in 1935 shows that 13.8 percent of its capacity has already been lost by silting which represents an average rate of depletion of 0.68 percent a year. If this rate should continue, an additional 84 years would see the capacity equal only to the normal annual draft, at which point any further depletion not compensated by new storage facilities would mean progressive decline in the valuation of most of the dependent developments to the point of exhaustion within a relatively few years.

Piedmont Reservoirs

In the southern Piedmont region practically all small reservoirs and many others of major size that are more than a few decades old are completely filled, except for a normal alluvial stream channel through the region of the original pond. There are literally scores of these smaller reservoirs, with dams 10 to 30 feet high, equipped to generate power running generally from 20 upwards to 500 horsepower, and for larger nondistributing plants up to 4,000 horsepower. At place after place in this region, abandoned power plants and dismantled machinery now stand as gaunt reminders of the ravages of excessive sedimentation on storage capacities and plant equipment and operation. Altogether, these smaller plants generate an important aggregate power. Their intimate distribution and service among rural and small urban communities of the Southern States for grist mills, yarn and weaving mills, makes their gradual deterioration particularly grievous to large segments of the population.

Only Part of Picture

These few examples of the destruction being wrought yearly by excessive sedimentation resulting from accelerated erosion induced by deforestation, overgrazing, unwise land use, and unscientific agricultural practices do not adequately illustrate the total loss of water-storage resources in the Nation; neither do they present a fair picture of conditions the country over, for as yet properly evaluated data on many regions, particularly the more northern States, are lacking. The data at hand, however, clearly show that not only is reservoir silting a problem of first magnitude in many regions, but also that the silting rates are neither uniform nor fixed in the different sections of the country but vary from place to place and from time to time, with respect to erosional production of debris in the watershed areas and with adjustment of reservoir capacity and shape to the size and characteristics of the watershed.

Roosevelt Reservoir, Salt River, Ariz. Mud cracks on drying silt surface exposed by lake drawdown. Background shows the width and depth of mud fill.

Notwithstanding the fact that preliminary estimates based on incomplete data furnished by State officials throughout the country indicate the existence of more than 1,200 storage reservoirs and more than 10,000 dams involving invested capital of several billion dollars, virtually no efforts have been made specifically to protect and preserve these indispensable resources from the common menace of exhaustion by silting.

This seeming apathy may be attributed, first, to almost universal failure to recognize or appreciate the excessive rates at which water storage is being lost in areas of accelerated erosion, and second, to a lack of fundamental knowledge on which effective remedial measures might be based. It has been, all too commonly, the accepted thought among engineers that reservoir storage would last until the project paid out, disregarding the danger to the social security of populations dependent upon such works. The seriousness of the situation is shown by the inroads already made upon developed reservoir resources, many of which are now exhausted, many more of which are in immediate danger within the coming generation, and few of which promise to outlive our known reserves of coal and iron unless early steps are taken to reduce and control excessive silt production at its source.

Previous Work

Previous to inauguration of sedimentation studies by the Soil Conservation Service, the records showed only 31 reservoir-sedimentation surveys in the entire country. By States, they included seven in Texas, four in California, three each in New Mexico and Tennessee, two each in Iowa, Wyoming, Colorado, and Ohio, and one each in Arizona, Oregon, Illinois, Minnesota, Maryland, and North Carolina. These surveys diverged widely in field methods and manner of computation. Several could be classified as little more than estimates, while on others the data were insufficient.

The total literature on silting of reservoirs in this country is confined to two Government bulletins, one State and one Federal, both relating primarily to the State of Texas, and less than one dozen original references in various engineering journals.

Work to Date

Studies of the silting of reservoirs were begun as a part of the soil conservation research program in July 1934.

The subsequent work has been greatly facilitated by the generous cooperative assistance of various Federal, State, and municipal agencies and many individuals in position to give indispensable information and aid. Important items of the program have been carried out under formal and informal cooperative arrangements with the United States Bureau of Reclamation, United States Coast and Geodetic Survey, United States Geological Survey, United States Forest Service, United States Bureau of Indian Affairs, Bureau of Agricultural Engineering, and the State water boards of Texas and Illinois. Acknowledgment is also due to the numerous municipal water

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boards, industrial concerns, and field operations offices of the Soil Conservation Service for assistance rendered.

In January 1935 three field parties of six technical men each were assembled and assigned to the southeastern, the south central, and the southwestern regions of the country. Through February 1936 reservoir investigations have included detailed surveys of 30 representative reservoirs and reconnaissance examination of more than 250 others.

Range of Survey

The reservoirs chosen for survey have varied in size from small headwater ponds of 18 acres surface,

Five-foot targets marking range end for sounding. White Rock Reservoir, Dallas, Tex.

draining a watershed equivalent to only two or three moderate-sized farms, to the immense Elephant Butte Reservoir on the Rio Grande in New Mexico, covering more than 40,000 acres and draining an area larger than the State of West Virginia, and Lake Mead above Boulder Dam on the Colorado River in the Southwest, which will impound the largest artificial body of fresh water yet contrived. The watersheds have been almost as diverse in land utilization as the reservoirs are in size. They have been representative of the rolling corn and tobacco lands of the southern Piedmont, the rich cotton-producing "black lands" and the higher grazing plains of Texas, the rugged Ozark foothills of the Arkansas-Missouri boundary, the arid plateaus and basins of Arizona and New Mexico, and the national forest and agricultural watersheds of California.

In addition to individual reservoir surveys, a State-wide reconnaissance of reservoir silting has been completed in Alabama, North Dakota, and South Dakota, and is now under way in North Carolina, Illinois, and California.

The present organization of personnel on this project includes three geologists detailed to reconnaissance investigations and three field parties consisting in each case of an engineer, a geologist, and four engineering aids of varied engineering and geological training.

Reasons for Study

Why should a survey be made of the amount of mud in a lake, when we all recognize it must be filling, from observation of erosion on the hills? Would it not be wiser to allot the same amount of money for dredging a lake or erecting a barrier at its head to catch the silt? Aside from the obvious disparity between relative costs of such operations and of research studies, the same questions might be suggested with equal logic to a flood. After all, we see the rainfall and we can tell by the height of the water in the river and number of people on the banks that a flood is in progress.

Why, then, study the effects of the flood and count the economic loss? It is, of course, so that we may be able, if humanly possible, to prevent a recurrence of the same destruction, so that we may determine the kind and height of flood protection works that are needed; and for more advanced students, so that we may understand and propagate sounder measures to check floods at their source. In the same manner, reservoir surveys and related special studies are undertaken to determine present silting rates and predict future trends, so that we may be prepared to take steps necessary to lessen silting rates by recommending watersheds most needful of soil-conservation planning, and by developing methods for abating the silting rate supplementary to established erosion-control practices.

The reasons for study of reservoir sedimentation are several. They fall naturally into three groups—first, those of assistance in planning the erosion control program of the Service, with respect to agricultural development; second, those related to protection of the reservoirs themselves which, together with flood control, comes under the broader scope of protecting all the Nation's resources from the menace of accelerated erosion; and third, those concerned with advancement of scientific knowledge of the processes and principles of transportation and emplacement of erosional debris. These reasons are taken into account in the scope and objectives planned for the project of reservoir investigations.

A complete inventory is being made, State by State, of the reservoir resources of the Nation and the effects of silting on their rate of exhaustion.

This will comprise full collection of data on reservoir characteristics, including storage capacity, surface area, use, type and size of dam, and area of drainage basin. The reservoirs of each State and physiographic region will be classified according to type, size, use, and tributary watershed characteristics. In addition, data will be collected and estimates made on the economic values involved in reservoir storage, and the effects of depletion by silting on the total water-storage resources of the country. Lastly, this Nation-wide inventory will serve as a basis for selection of the most significant examples in each State for detailed surveys and special studies.

Future Reservoir Planning

Detailed sedimentation surveys of individual reservoirs being made in regions of various types will afford a sound basis for future reservoir planning and design. Heretofore, most reservoirs have been constructed without adequate data on which the life span of the storage basin could be reliably predicted. In numerous instances, this has resulted in total exhaustion or critical impairment of storage even before the initial cost of the reservoir has been amortized. A series of widely scattered and representative surveys correlated with determined watershed conditions is expected to influence the locations, the sizes, and the dam designs of future reservoirs, by making available definite information on the prospective rates of silting. With such data, it will be possible to prevent considerable economic loss by adjusting reservoir plans to watershed characteristics.

Erosion Measurement

The detailed surveys of reservoir silting will establish controls for measurement of average net erosion in representative drainage basins. A quantitative survey of sediment in any reservoir is a measurement of erosional debris delivered from its tributary watershed during the life span of the storage basin to the date of survey, minus the fraction that has escaped past the dam in outflowing water. It is not in itself a measurement of total erosion in the watershed, but through correlation with detailed watershed surveys of soil, slope, climatic and vegetative conditions, including local plot measurements and special studies, it is expected that an evaluation factor will be derived to express the net average rate of erosion for the watershed as a whole. For that reason, it is particularly important that reservoir studies should be not only widely scattered geographically, but should include a range of reservoir types, draining watersheds varying from a few fields to thousands of square miles and taking in the greatest possible variation of watershed conditions. Reservoir studies are of particular value in indicating and affecting choice of those areas demanding priority of effort in propagating effective erosioncontrol practices. Since all initial reservoir surveys are accurately monumented, it will be possible to repeat the measurements from time to time to establish progressive trends in silting rates as reflecting constantly changing watershed conditions, and particularly the changes due to accelerated erosion and erosion control.

Close-up view of 6-foot silt sampling spud and sounding pea.

Supplementary Control Methods

Special studies of the processes and characteristics of reservoir sedimentation are being made in order to develop methods of silt control supplementary to established erosion control practices. It is recognized that widespread and completely effective erosion control, even throughout the agricultural regions of the country, will not be established in the course of a few years. On the semimarginal, arid, and desert lands, particularly of the Southwest, erosion will not be reduced to its geologic norm on a widespread scale for many generations, if ever. Thus we may anticipate silt production, transportation, and deposition in our reservoirs as a continuing process for an indefinite period of time, though of diminishing order in many regions as erosion control becomes more effective. Temporary abatement of reservoir-silting rates by developing methods of partially bypassing silt through reservoirs, by permanently controlling particular sources of silt production and by studied em-

(Continued on p. 14)

PARTY "SHOOTS" COLORADO RIVER GORGE FOR SILTING AND EROSION INFORMATION

By Solon R. Barber

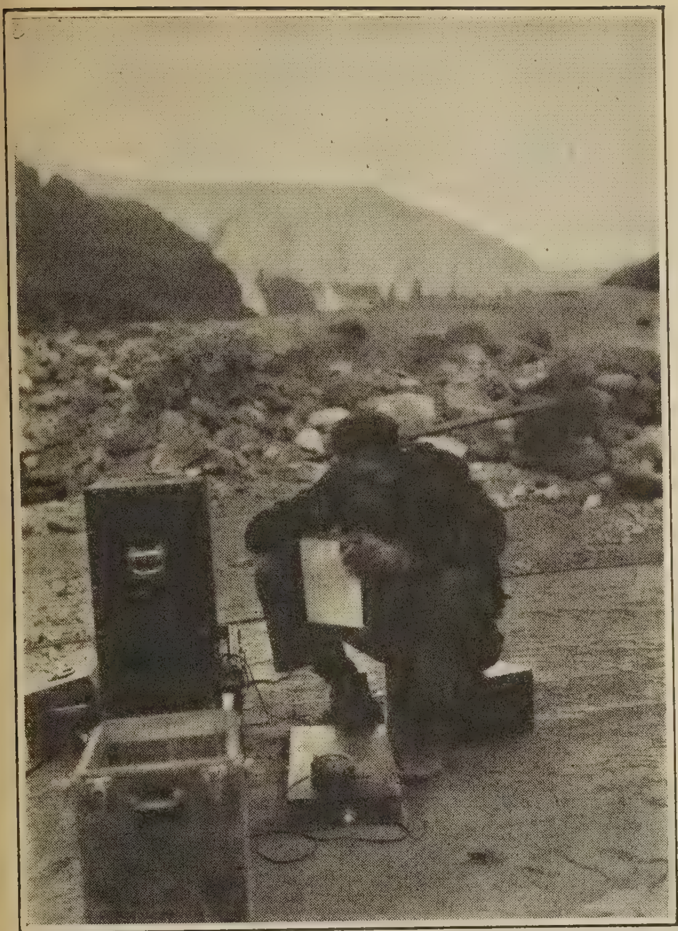
Danger below! Two of the boats making ready to head off down the rowdy Colorado. All instruments and supplies were carried in water-proof boxes.

Silt-clogging of the Boulder Reservoir and of the quiet pools higher up the Colorado River is caused by soil erosion on the river's watersheds and, it is hoped, can largely be controlled at the source by proper soil-control measures.

Preliminary reports of a recently completed Soil Conservation Service surveying expedition down 55 hazardous miles through the Lower Granite Gorge of the Colorado, never before precisely surveyed, show that the bulk of the silt washed into the reservoir comes from a relatively small area of watershed.

This silt, once valuable soil, is blown and washed down into the river from the high plateau watersheds in the Navajo Indian Reservation in northeastern Arizona and the Ute Indian country in northwestern New Mexico, and is beginning to fill one of

Huge silt beds along a relatively quiet pocket of the Colorado River, ready to break off and be carried down the swift river.



The expedition carried an efficient portable radio set and river station KBAZ functioned at camping grounds along the route.

Uncle Sam's newest and most valuable water-storage reservoirs.

The surveying expedition, headed by Edward A. Schuch of the Service, involved aerial, ground, and hydrographic measurements and mapping of the Colorado River from the mouth of Diamond Creek to a location 6 miles below the present high-water mark of the reservoir, and furnished the most accurate information on the region thus far secured. So precise were the surveys that the error was less than 1 foot in 20,000 feet.

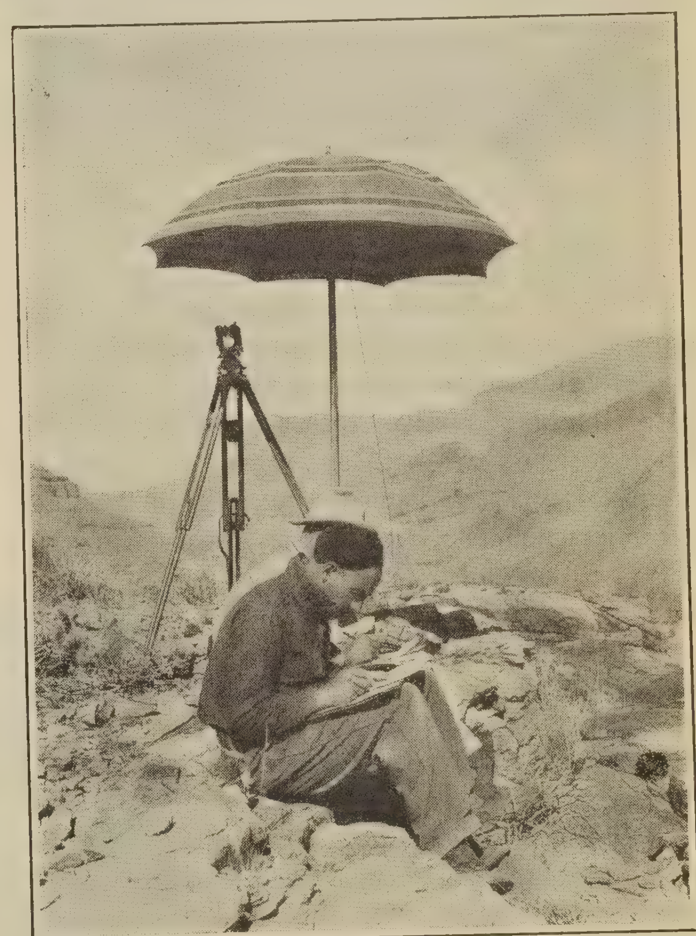
"The expedition found deposits of silt as much as 10 feet deep and 300 feet wide in pockets and pools above Pierce's Ferry", Mr. Schuch reported.

"In order to negotiate the dangerous rapids of the river, the party used four special nonsinkable boats built of Philippine mahogany. Supplies and equipment were carried in waterproof boxes, since every precaution had to be taken to protect the delicate and valuable instruments. Twelve men composed the party: engineers, survey specialists, experienced rivermen, and a guide.

"Information obtained by the expedition will be valuable to the Soil Conservation Service in working out plans to protect the large population who depend upon the water supply gained by damming the Colorado and to additional thousands who live on the Navajo and Ute plateaus where accelerated soil erosion is an all-too-painful reality."

Erosion Control Dire Need

The gates of Boulder Dam were officially closed on February 1, 1935. Late last autumn, the water in the reservoir rose nearly 300 feet higher than the original river level. When the lake is filled, it will be approximately 130 miles long and 600 feet deep. Its water will supply countless city homes, power plants, farms and orchards. Control of erosion with its resultant silting and sedimentation thus becomes of



Mapping things out. One of the expedition's engineers is shown recording measurements and observations. Quiet but very hot.

The expedition's boats securely moored in a quiet pool.

vital concern to several million people. When filled with billions of tons of water, the Boulder Reservoir will probably cause a slight change in the topography of neighboring country, according to Mr. Schuch. The Coast and Geodetic Survey has undertaken, by means of extremely accurate surveys, to determine the exact amounts of such changes as they may occur.

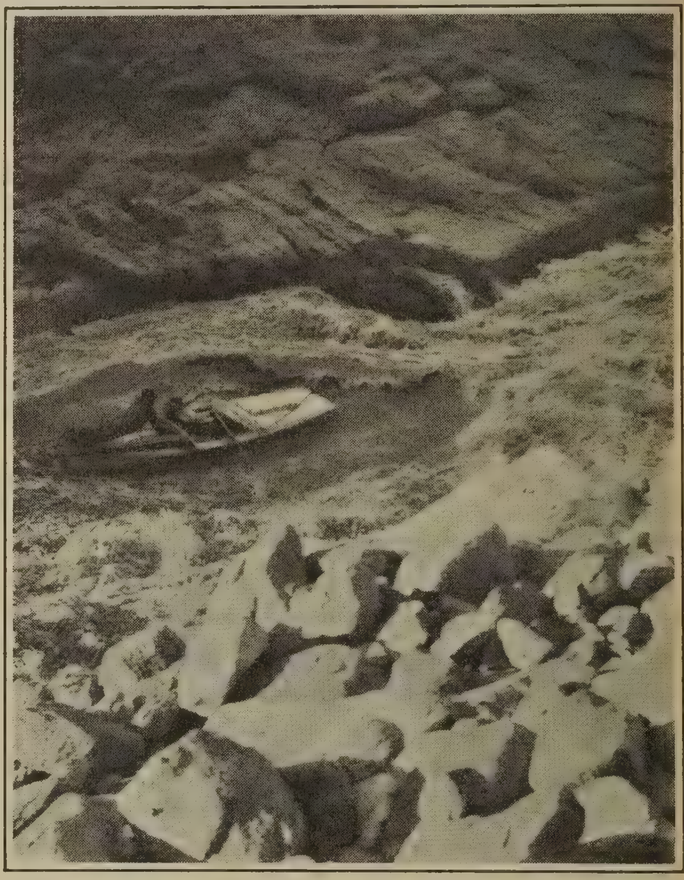
Careful Survey Required

About a year ago, it was decided that an accurate contour map of the area that will comprise the Boulder Reservoir is necessary in order to carry out the Service's silt and erosion studies in the Colorado Basin. In order to map this area by photogrammetric methods, a network of horizontal and vertical controls had to be established in such manner that four identifiable control points would fall within the limits of each stereoscopic model. The necessary ground control had been completed with the exception of 55 miles of the Colorado River which runs through the Lower Granite Gorge. As it is impossible to travel upstream on this "river of no returning," the expedition planned to carry the control from the United States Coast and Geodetic Survey stations at Peach Springs down through Peach Springs Canyon into Diamond Creek and then down the Colorado to Pierce's Ferry. Mr. Schuch, as chief photogrammetrist of the Service, was placed in charge of the expedition. He was assisted by George McGathen, a civil engineer in Government service.

The survey party left Diamond Creek September 26, 1935, and headed downstream. The survey was completed in 45 days.

Radio Station Set Up

The expedition fully understood the necessity of keeping in close and rapid communication with Washington, D. C., headquarters and stocked an efficient portable radio set. River station KBAZ was set up in the camps and messages were relayed through the courtesy of the United States Forest Service Desert Range Station, KBAY, Milford, Utah, to Los



Watch those boulders! One of the expedition's nonsinkable boats "shooting" the rapids of the Colorado. The boats sped down, stern first, the boatman rowing against the current.

From the heights. Three 17 foot boats of the expedition speeding down the Colorado River, pale into insignificance against the looming stone walls of Lower Granite Gorge.

Angeles and Washington. Messages and findings were radioed daily, with the exception of 1 or 2 days when wind and rain storms whipped through the winding passes.

Radiogram, November 11, 1935, Station KBAZ to KBAY:

> We are camped just above Separation Rapids. Will be here 2 or 3 days. In 1869 a party separated at Separation Rapids. A bronze tablet on the side of the canyon wall tells about it.

The party that separated was the famous Powell Expedition.

Radiogram, November 10, 1935, Station KBAZ to KBAY:

> We are using about 40 pounds of food per day. Will have enough food with that which is cached to last 35 to 40 days from now. The survey work is going faster. We were able to make seven stations.

These terse messages, reporting findings, requesting information, giving camp and field locations, came out nightly from the pitch-dark depths of the Colorado gorges. That portable radio was the men's one means of keeping in touch with the world above them. Mr. Schuch reported that, outside of the members of the expedition, not a soul was seen while they were working along the floor of the mile-high canyon.

Now that the first survey of the region has been completed, specialists have set to work to bring together all the findings secured by the expedition in a set of elaborate contour maps of the reservoir and the watershed areas involved. Some of these maps will be on a grand scale, one being on a 10-foot scale drawn in minute detail.

Every facility was used to obtain the information needed for making precise maps. The party took about 2,500 feet of motion pictures, some in colors. In addition, several hundred still photographs were taken. The pictures will be extremely useful not

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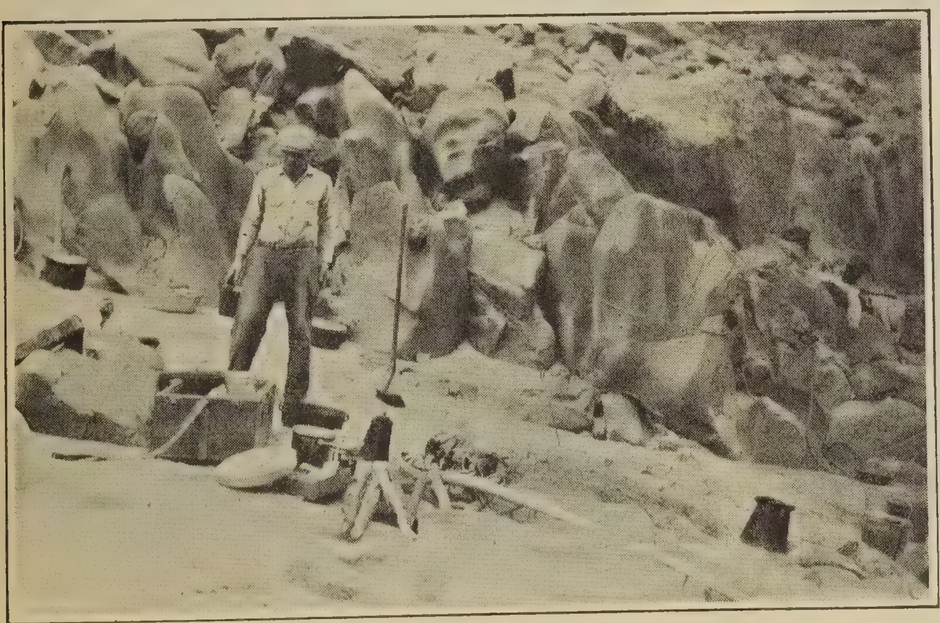


A stop for coffee--but no doughnuts. The chef puts the pot on for the tired men about to appear.

HYDRAULIC STUDIES OF EROSION CONTROL

By J. T. McAlister [1]

Work began on a field hydraulic laboratory at Gilreath's Shoals on Beaverdam Creek near Tigerville, S. C., in August 1935, under the direction of Prof. R. C. Johnson, of the University of South Carolina, consultant engineer for the Soil Conservation Service, and D. W. Cardwell, junior agricultural engineer. Labor was furnished by C. C. C. enrollees from Camp Buie. A reservoir at the laboratory impounds approximately 500,000 gallons of water. The dam is a gravity-section rubble masonry type having a spillway crest 5½ feet deep, which takes care of flood flows. It is set in a natural key in the bedrock at the head of shoals which drops 40 feet in 200 feet. This unusual fall allows for ample test-channel space around the side of the hill where the experimental set-up joins the main supply channel from the reservoir.

Arrangement of Control Channel

The control channel in which the water is measured in cubic feet per second is arranged so that water enters through a large control gate which can be adjusted for required amounts of flow. A loose rock baffle stills the water before it passes on to a 24-inch Gurley hook gage placed back of a sharp-crested pine weir, 3 feet wide and topped by a 1-inch strip of copper. The weir is calibrated and shows the normal creek flow to be from 1 to 2 cubic feet per second, varying, of course, with the season. With the headgate open, the maximum flow of water is about 12 cubic feet per second, obtained for a short period of time.

Dam To Be Raised

Plans have been made to raise the height of the dam by 2 feet in order to increase the quantity of flow in the test channel.

The headgate control channel is to be extended in order to improve the entrance conditions and the method of measuring the amount of flow.

In general, the experimental work has been limited to conditions peculiar to the Piedmont area. However, some of the data are applicable to other sections.

The test channel is such that full-size structures may be installed and a complete study of the function of structures may be made before field construction begins. The proper method of construction may be determined and the proper recommendations made. In this way proposed field installations are studied in a systematic manner and many failures in the field are eliminated.

Tests Being Made

Tests which have been completed or are in progress include:

1. Determination of the proper discharge coefficient of rectangular masonry notches for vertical overfalls.
2. Development of information concerning stabilizing soils with portland cement for use in erosion-control structures.
3. Determination of proper designs of dams, baffles, flumes, and high-velocity channels and studies of the permissible velocities for different types of vegetative treatments.

One experiment of particular interest utilizes two terraces which will be tried under conditions similar to a heavy rain. Data as to the proper terrace specifications will be obtained. By planting the terrace intervals, the erosion-resisting qualities of various crops are to be ascertained.

The field laboratory provides an opportunity for technical and construction supervisors to observe the action of water on actual field installations.

Demonstrations have also been held at the laboratory for farmer groups, agricultural students, highway engineers, and maintenance superintendents.

[1] The author is agricultural engineer, Soil Conservation Service, Spartanburg, S.C.

WIND EROSION IN UTAH

Holes as large as 6 acres in area and as deep as 15 feet are reported as having been blown in once-valuable grazing lands of Utah, where the Soil Conservation Service maintains its Tooele-Grantsville demonstration project.

One recent 8-hour windstorm left 76 pounds of dust on a 9-by-12-foot rug in a tightly built house.

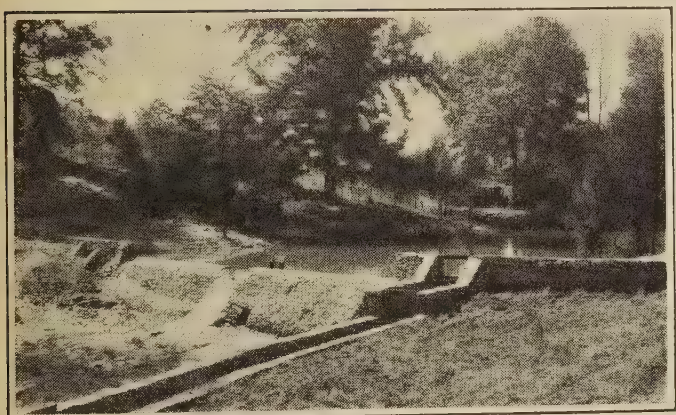
A transcontinental airplane at 22,000 feet encountered dust in such quantities that it was forced to turn back, in the interest of safety.

Dust storms in this locality are attributed largely to overgrazing, and the Soil Conservation Service is undertaking revegetation on a large scale. Crested wheat grass, introduced from Russia, is among the grasses which are showing promise. Contour ridges are plowed to hold the rain where it falls.

BERMUDA SOD FLUME ON A 22½ PERCENT SLOPE BEFORE WATER WAS ALLOWED TO ENTER.

BERMUDA SOD FLUME SHOWING FLOW OF WATER WITH A VELOCITY OF 14 FEET PER SECOND.

BERMUDA SOD FLUME AFTER WITHSTANDING A VELOCITY OF FLOW OF 14 FT. PER SECOND FOR 25 MINUTES. BERMUDA SOD WAS PLACED 2 WEEKS BEFORE EXPERIMENT.



A GENERAL VIEW OF THE HYDRAULIC LABORATORY LOCATED ON BEAVERDAM CREEK NEAR TIGERVILLE, SOUTH CAROLINA. THE CONTROL GATE AT THE ENTRANCE OF THE MAIN TEST CHANNEL IS SEEN IN THE FOREGROUND.

A FLOW OF APPROXIMATELY 10 CUBIC FEET PER SECOND.
1-A TWO INCH THICK CONCRETE BAFFLE. 2-A FOUR INCH THICK RUBBLE CONCRETE BAFFLE. 3-A SIX INCH THICK STABALIZED CLAY BAFFLE.

BAFFLE STRUCTURES SHOWING SEVERAL HOURS OF FLOW AT THE RATE OF 10 CU. FT. PER SECOND. NOTE THE SCOURING DOWNSTREAM FROM BAFFLES.

BAFFLE STRUCTURES AFTER APPROXIMATELY DOUBLE THE TIME OF FLOW.

HOW GULLIES ARE CONTROLLED BY VEGETATION IN SOUTH CAROLINA

By George L. Harmon

Gully on farm in South Carolina, caused by improper terracing of fields.

Same gully after banks were sloped by bulldozer, terrace lines surveyed and contour terraces constructed. Diversion ditch at head diverts flow of water from surrounding drainage area. Bermuda grass shown fringing the drainage area, being established by sodding on terrace ridges. Water that falls on area carried to lower end of gully by terrace channels. Entire area seeded to mixture of small grain. Black locust trees planted during past season.

In South Carolina vegetation is proving adequate for the control of a number of large gullies. Not only is it giving permanent protection against erosion, but it is also affording food for wildlife, grazing for livestock, and trees for fuel, fence posts and building materials.

We divert the flow of water when that is possible. We usually cut a diversion ditch above the head of the gully or accomplish our purpose by so terracing the land as to drain away the water. We like to lead the diversion ditch into a woodland or some other protected area. In some instances, particularly when a gully occurs in a large cultivated field, we find it necessary to protect the water channel or diversion ditch. Narrow bands of Bermuda grass sod are used, the distance between them varying with the steepness of slope. If it is not possible to use a diversion ditch, a flume sodded with Bermuda is used to conduct the water into the channel of the gully. When the heads of gullies are perpendicular, as is usually the case, it is necessary to cause the water to "walk" rather than run down the sloped portion, thus reducing the cutting power to a minimum.

Sloping Gully Banks

Gully banks are sloped as an aid to controlling gullies by vegetative methods. Sloping is done by the use of a bulldozer or explosives, or by hand labor. The first method, being the most economical, is preferable. The gully banks are usually brought to a grade not greater than 40 percent. Soil pushed in raises the bottom of the gully by several feet.

Contour Terracing

Contour terracing has proved very satisfactory on the sloped banks. In constructing these contours, terrace lines are surveyed so as to drain the water from the area being treated to protected areas on either side. A ridge is then built on the surveyed line resembling the farmer-built, "bench-like" terraces. The ridge is approximately 2 feet high and about the same width at the base. It is sodded on top with Bermuda grass or seeded to a mixture of small grain. The ditch on the upper side collects the water and carries it to the discharge point, either wooded or other protected area or into a protected water channel. Bands of Bermuda sod are placed in the gully channel perpendicular to the slopes. When the slope is very steep the channel is sodded solid with Bermuda.

If terraces are not constructed on the contour, the banks are planted to narrow strips of Bermuda sod, honeysuckle, or kudzu on the contour. The strips of Bermuda are approximately 2 feet wide, the vertical interval varying with the slope of the land. The entire area is then seeded to a close-growing annual plant. Small grains—rye, oats, and Italian rye—are

FROM TOP TO BOTTOM

Narrow strips of Bermuda grass placed on contour slopes and across channel of gully in Spartanburg County, S. C., in fall of 1934. Banks had been sloped with bulldozer. Diversion ditch at head diverts flow of water from adjacent territory into wooded area at left.

One year's growth of small grain and black locust trees in gully shown above. Picture taken in September 1935. Gully was formerly very active with perpendicular banks and approximately 35 feet deep before treatment.

Gully approximately 30 feet deep and rapidly advancing into woods, uprooting large trees.

The same gully after banks were sloped, contour terraces constructed and preparation made for planting vegetation. Gully is line between two farms and is the result of road water being discharged into the area. Diversion ditch diverts road water into nearby protected area.

used in the fall and winter, and lespedeza, sorghum cane, and Sudan grass are seeded in the spring and summer. These annuals serve as nurse crops until the grass or trees are well established. Black locust is planted at 4-foot intervals over the entire area and will provide permanent protection within a few years.

Some gullies are being treated with vegetation without sloping the banks. This method is the least expensive but does not bring about maximum control in as short a time as when the banks are sloped. A few gullies have been treated by direct seeding of black locust in narrow contour rows, while others have been planted to locust seedlings, honeysuckle, and kudzu crowns. We do not find it advisable to plant black locust and kudzu together.

Bermuda grass and black locust are at present the best plants in South Carolina for gully control. Bermuda is the only grass that will survive on badly eroded land. The locust makes a very rapid growth and will furnish fence posts for the farmer in from 8 to 12 years.

The South African Farmer reports that in the year ended August 1935, 5,500 applications for assistance has been received by the South African Department of Agriculture, which is making an effort to control soil erosion.

Experiments conducted at the Spur, Texas Station, show that buffalo grass retains 82 percent of rainfall, in comparison with 55 percent of by cotton.

PARTY "SHOOTS" COLORADO

(Continued from p. 9)

only in making maps but in the surveys to be undertaken later.

Objects of the Survey

The principal objective of the expedition was to gain information that will be used in the future in determining the rates of silting in the reservoir. Knowledge of these rates will be necessary for formulation of policies and practices of silt control on the watershed.

Soil wastage is denuding once valuable farm lands in the Navajo and Ute Indian country and impoverishing the Indians as well as the white settlers. Thickly-populated country in the Los Angeles metropolitan and southern California areas are particularly affected, since excessive sedimentation of the reservoir would threaten city water supplies, storage reservoirs, waterways, irrigation canals, and power plants.

"The Soil Conservation Service, in cooperation with other agencies, will make use of every known applicable method of erosion control in the areas affected", said H. H. Bennett, Chief of the Service. "These will include the limiting or halting of grazing on eroded and erodible areas; the planting of grass and other cover crops to bind the precious topsoil; the construction of check dams, wiers, and settling basins, and the use of any other necessary mechanical or vegetative erosion-control methods."

Extracts From Log

Logs kept by members of the expedition furnish interesting day-by-day records of the trip.

Food supplies consisted mainly of dried fruits, flour, beans, rice, coffee, canned meats, and bacon. On one or two occasions, fresh meat was killed along the river. Mr. Schuch reported that the men feasted on fresh meat on Thanksgiving Day—a young wild burro which was shot and from which the choice cuts were taken.

Camp sites were hard to find along the winding floor of the canyon. Some of the camps were pitched on small sand bars which would ordinarily be perilous. River reports received by the party warned the men of coming high water and consequent danger to their camp sites.

Water from most of the side streams feeding the Colorado was found to be bad. The party allowed the water from the main river to settle for drinking purposes. It was muddy, but usually better than water from the branches.

Separation Rapids and Spencer Rapids proved to be the most hazardous, but both were "shot" without injury.

"My first impression of the gorge", Schuch wrote, "reminded me of Paul Bunyan's stories of the Powder River in Montana, which he described as a mile wide and an inch deep. The gorge could be described as the Powder River turned on edge."

STUDIES OF SILTING

(Continued from page 5)

placement of the silt load before it enters the reservoir is an objective of major importance. The special research investigations being inaugurated include studies of delta and up-valley sedimentation and means of permanently fixing this sediment through inexpensive engineering structures and vegetative control; studies of wave erosion on shore lines and methods of its prevention; studies of topographic and geologic conditions favorable to temporary desilting basins adjacent to reservoirs; studies of the "tunneling" or underflow of silt-laden water through a reservoir and possible means for utilizing this phenomenon in bypassing silt such as modified dam design; studies of the physical and chemical properties of reservoir silt and its value or harm if applied to agricultural lands; and studies of sources of silt with a view to controlling particular source areas which may be furnishing an abnormal ratio of the total incoming sediment.

Silt Measurements During Potomac River Flood

On Thursday, March 19, 1936, during the height of the Potomac River flood, Carl B. Brown, of the Division of Research, collected a sample of water which contained a very striking silt content.

This sample was taken from an abutment of Chain Bridge, 5 miles above Washington on the Virginia side. Being from the upper foot of water moving downstream, and farthest removed from the center of the current, which was flowing at approximately 25 miles per hour, it should represent the minimum content of suspended load being carried by the river.

According to analysis by the United States Geological Survey, the sample had a content of suspended matter of 5,420 parts per million, or more than 0.5 percent suspended matter. At the time this sample was collected the estimated discharge of the river was between 390,000 and 400,000 second-feet If this tremendous discharge contained as a minimum 0.5 percent solid matter, the Potomac River was moving down to the sea at this stage 2,000 cubic feet of silt per second or 7,200,000 cubic feet per hour.

FLOOD CONTROL WORK IN ITALY

By Albert Chiera [1]

Control of the watershed Sorgenti del Sele *by reforestation.*

In Italy, where artificial means of control have been extensively used, floods have continued to occur regardless of dams or the usual type of levees. Because of this, extensive reforestation is now being undertaken on denuded mountain sides.

The accompanying photograph evidences the potential power of vegetation to restrain run-off waters. With the multiplication of such works as these, Italy expects to accomplish the control of many mountain streams and the reduction of floods.

On the plains a supplementary method of control consists in moderating the effects of floods by allowing a river laden with sediment to spread out, lose its velocity, deposit silt, and build up lowlands. A series of levees is built, subdivided at intervals by cross levees, to form a network of huge catch basins. The first line of levees is broken up by openings to permit the water of the river, when rising, to flow into the catch basins and be impounded by the closing of sluice gates. The water, losing its velocity, deposits its silt, and when clarified is permitted to flow back to the river upon recession of the flood. By successive inundations the land is built up.

These catch basins during floods act as temporary reservoirs, to be silted up as a last objective, so that finally the land is raised above the possibility of flooding. This method of meeting the flood problem is described in A. Fanti's book *La technica e la pratica delle Bonificazioni*, but it is on the reforestation of denuded mountain slopes that Italian engineers are chiefly relying for a definite solution.

[1] The author is translator and research assistant in the Soil Conservation Service.

Will Direct Woodland Management

John F. Preston has been appointed head of the Section of Woodland Management, according to announcement by H. H. Bennett, Chief of the Soil Conservation Service.

Beginning in 1907, Mr. Preston served in the Forest Service for 18 years. This association included periods as supervisor of the Beartooth and Blackfeet Forests in Montana, chief of the branches of operation and forest management in Montana and northern Idaho, and work in forest management at Forest Service headquarters in Washington, D. C. For the last 10 years he has been forester for a large paper company.

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

A Contribution from The Soil Conservation Service Library

MICHIGAN WATERFOWL MANAGEMENT. By Miles David Pirnie. 1935.

The author's chief concern is to present the topics which are most pertinent to the efficient handling of present and future waterfowl problems. Of particular interest are the notes on nesting and migratory habits of dabbling ducks, diving ducks, mergansers, wild geese and swans, coots and grebes, and the double-crested cormorants.

The mallards—especially vigorous birds, which because of the migratory-bird treaty with Canada are still plentiful in the northland—haunt brushy marshlands where there is abundance of sedges and cat-tails. Their nests, little more than hollows on the ground, are often found as far as half a mile from the water. The eggs are greenish white, and clutches average 11 or 12. When incubation is advanced, a roll of soft down from the breast of the old duck encircles the nest and serves as a blanket to keep the eggs warm while the bird is away seeking food. In late April or May the broods hatch, and, soon after, the fluffy yellow and black ducklings, crowded in a tight cluster, leave the nest with the mother for their first swim. Within 10 weeks they are almost full-grown and able to fly, and by the last of July many broods are on the wing. It is in June that the drakes acquire their eclipse plumage, in which they no longer have green heads or gray bodies but resemble the dull coloration of the hens. The bills fade from rich yellow to olive green. Later, by another molt, the drakes again acquire their green head-dress and the bars of white which frame the iridescent green and purple patch of the inner wing feathers.

It is during these periods of incubation and molting that it is exceedingly important that mallards, and all other waterfowl, be protected from food shortage resulting from droughts or fires, from hunting mortality, and from disease.

Foxes, coyotes, hawks, serpents, pike, and snapping turtles, the great horned owl—these are the natural enemies of waterfowl; yet their depredations in duck colonies are small indeed compared with losses from such diseases as botulism and the protozoan disease, malaria-like in symptom and stages, which is transmitted by the bite of black flies. Little is known thus far about the diseases which destroy many wild swans, ducks, and geese, and it is suggested by the author that hunters, conservation officers, and other out-of-door people can render valuable aid by notifying the State Department of Agriculture or the Department of Conservation of any disease troubles in wild birds or in captive flocks, and by sending sick or dead birds to the State pathologists for examination.

As for waterfowl mortality from shooting, assume that a flock of 100 ducks or geese, healthy and strong, leave a northern breeding area in September. On their migration they are repeatedly fired upon and by the end of the shooting season just one-half or 50 of them may drop out, the victims of gunning, predators, diseases, and accidents. With even moderately good fortune, can the remaining 50 again restore the flock to the original 100 to start southward the following autumn? It is not likely. It is a problem for organized wildlife management and the waterfowl program.

The aims of waterfowl management in Michigan, where much wildlife research has been done, are summed up by Dr. Pirnie as follows: (1) To inventory waterfowl, both nesting and migrant; (2) to evaluate the destructiveness of gun, predators, diseases, and all other known destroyers of waterfowl; (3) to develop a plan for waterfowl protection, increase, and more widespread use and appreciation; (4) to improve conditions for waterfowl, especially in connection with water storage, fish, and fur production; and (5) to consider Michigan waterfowl questions and programs as a part of and not separate from the national waterfowl situation.

According to Dr. Pirnie's studies of the killing of leg-banded black ducks and mallards, the evidence piles up in favor of hunting restrictions, with the shorter season accompanied by low decoy and bag limits, and the importance of refuges and sanctuaries.

Dr. Pirnie has written extensively about the feeding habits and plant and animal resources of Michigan waterfowl. Widely varied is the diet of wild duck, goose, coot, swan, and grebe. From acorns to watercress, all down the line of succulent green pondweeds, and from crayfish to crane-fly larvae, the waterfowl eat their way through the seasons. It is in waters rich on organic matter, as where sod and logs are flooded at beaver ponds, that the coots, teal, and black ducks seem to thrive best, for there is to be found the great variety of plant and small animal food which they require.

Included in the book is a chapter on food and cover planting recommendations, with a table listing 28 plants, seasonal notations, and directions as to source and method of planting. This chapter is illustrated by a series of especially fine photographic plates.

There are notes on restocking and propagation of waterfowl species, predator control, and management programs.

The appendix contains a key to 50 aquatic plants of Michigan; notes on sample meals of ducks taken in Michigan; and a bibliography of references on waterfowl conservation and natural history. Pocket maps accompany the text. There are over 200 photographs.

THE LAND NOW AND TOMORROW. By R. G. Stapledon. London, 1935.

The author is professor of agricultural botany, University of Wales, Aberystwyth, and director of the Welsh plant-breeding station. His book deals, primarily, with planning for proper utilization of the land surface of Great Britain; or, to use his own expression, "the countryman's aspect of catering for posterity." The discussion involves many and various technicalities for land improvement and the conservation of fertility. Some of the subjects treated in detail are: Grassland reclamation versus reconditioning; cotton grass or Dyer's greenweed; Nardus or mat grass pastures; Molina or blue moor grass and fescue; permanent grass, Agrostis and ryegrass; reversion to bracken and rushes; excessive weediness; dairy pastures; the problem of grouse moors and sheep; the place of legumes and miscellaneous herbs.

Does it pay to sow wild white clover, to manure, to maintain land in high-class temporary grass? The author gives the results of his experiments in Wales in answer to these questions.

Afforestation and plantation arrangement in Great Britain is described, with numerous suggestions for recreational planning. An exceptional chapter on the national park is included, with accompanying topographical and vegetational maps. Aside from its technicalities, The Land Now and Tomorrow is a readable volume, propounding the many-sided ideals of the ruralist who loves the rural life. The chapters are illustrated by photographic scenes from the hills and valleys of the author's native Wales. The text is supplemented by an extensive bibliography on rural planning and agronomical subjects. There is an 11-page index.

A GENERAL INTRODUCTION TO FORESTRY IN THE UNITED STATES; with Special Reference to Recent Forest Conservation Policies. By Nelson Courtlandt Brown. 1935.

A general treatise on the subject of forestry, presenting types of forests; leading commercial tree species, with silvicultural systems of cutting and methods of artificial reproduction; nursery seeding and transplanting practices; the best logging methods; modern practices of lumber manufacturing and conditioning; wood uses and economics; reducing waste in forests and sawmills; forest products aside from lumber; methods of timber preservation, and directions for conducting forest research.

U. S. GOVERNMENT PRINTING OFFICE: 1936

PUBLICATIONS ON VARIOUS PHASES OF EROSION CONTROL

Compiled by Etta G. Rogers, Publications Unit

Field offices should submit requests on form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.[1]

Soils

Composition and Constitution of Colloids of Certain of the Great Groups of Soils. Technical Bulletin 484. December 1935. U. S. Department of Agriculture.

Fertilizer Tests on an Important Pasture Soil Type. Bulletin 306. January 1934. Agricultural Experiment Station, Amherst, Mass.

Index for Rating Agricultural Value of Soils. Bulletin 556. September 1933. Agricultural Experiment Station, Berkeley Calif.

Laboratory Study of Field Percolation Rates of Soils. Technical Bulletin 232. January 1931. U. S. Department of Agriculture.

Physical and Chemical Characteristics of the Soils from the Erosion Experiment Stations. Technical Bulletin 316. June 1932. U. S. Department of Agriculture.

Physical and Chemical Characteristics of the Soils from the Erosion Experiment Stations—Second Report. Technical Bulletin 430. August 1934. U. S. Department of Agriculture.

Principles of Liming of Soils. Farmers' Bulletin 921. April 1930. U. S. Department of Agriculture.

Sandy Soils. Methods of Management. Bulletin 248. August 1934. Agricultural Experiment Station, East Lansing, Mich.

Soil Fertility Studies. Bulletin 290. June 1933. Agricultural Experiment Station, Fayetteville, Ark.

Soil Testing, A Practical System of Soil Diagnosis. Technical Bulletin 132. April 1933. Agricultural Experiment Station, East Lansing, Mich.

Study of Methods for Preparation of Permanent Soil Profiles. Technical Bulletin 201. January 1932. Agricultural Experiment Station, Oklahoma A. & M. College, Stillwater, Okla.

Vegetation

Alfalfa Varieties in the United States. Farmers' Bulletin 1731. September 1934. U. S. Department of Agriculture.

Crotalaria, A New Legume for the South. Circular 137. February 1931. U. S. Department of Agriculture.

Grass in Soil Erosion Control. SCS-TP-4. January 1936. Soil Conservation Service.

Growing Alfalfa. Farmers' Bulletin 1722. March 1934. U. S. Department of Agriculture.

Huron Timothy. Leaflet No. 99. August 1933. U. S. Department of Agriculture.

Kudzu, A Forage Crop for the Southeast. Leaflet 91. April 1932. U. S. Department of Agriculture.

Soybean Hay and Seed Production. Farmers' Bulletin 1605. October 1929. U. S. Department of Agriculture

Sudan Grass. Farmers' Bulletin 1126. January 1935. U. S. Department of Agriculture.

Summer Crops for Green Manure and Soil Improvement. Farmers' Bulletin 1750. September 1935. U. S. Department of Agriculture.

Sweet Clover. Leaflet 23. May 1928. U. S. Department of Agriculture.

Vine-Mesquite for Erosion Control on Southwestern Ranges. Leaflet 114. February 1936. U. S. Department of Agriculture.

Winter Legumes for Green Manure in the Cotton Belt. Farmers' Bulletin 1663. February 1936. U. S. Department of Agriculture.

[1] Requests from other than the S. C. S. staff for departmental publications should be submitted to the Office of Information, U. S. Department of Agriculture, Washington, D. C. It is requested that numbers be listed in consecutive order.

Farm Practices

Control Soil Erosion by Crops, Terraces, and Dams. Circular 249. December 1931. Extension Division, University of Wisconsin, Madison, Wis.

Controlling Small Gullies by Bluegrass Sod. Leaflet 82. December 1931. U. S. Department of Agriculture.

Farm Drainage. Farmers' Bulletin 1606. October 1929. U. S. Department of Agriculture.

Farm Practice with Lespedeza. Farmers' Bulletin 1724. March 1934. U. S. Department of Agriculture.

Farm Terracing. Farmers' Bulletin 1669. March 1935. U. S. Department of Agriculture.

Growing Alfalfa. Farmers' Bulletin 1722. March 1934. U. S. Department of Agriculture.

Influence of Systems of Cropping and Methods of Culture on surface Runoff and Soil Erosion. Research Bulletin 177. March 1936. Agricultural Experiment Station, Columbia, Mo.

Maintenance of Crop Production on Semi-Arid Soil. Popular Bulletin 138. August 1927. Agricultural Experiment Station, Pullman, Wash.

Pasture Fertilization. Bulletin 323. September 1935. Agricultural Experiment Station, State College, Pa.

Soil Erosion Control in Farm Operation. Special Bulletin 170. August 1935. Extension Division, University of Minnesota, Minneapolis, Minn.

Soil Productivity as Affected by Crop Rotation. Farmers' Bulletin 1475. May 1926. U. S. Department of Agriculture.

Strip Cropping. SCS-TP-2, May 1935. Soil Conservation Service.

Strip Cropping to Prevent Erosion. Leaflet 85. November 1931. U. S. Department of Agriculture.

Terraces Effective for Controlling Erosion on Cultivated Land. Yearbook Separate No. 1418. Yearbook of Agriculture. 1934. U. S. Department of Agriculture.

Terracing to Prevent Erosion. Circular 317. February 1935. Extension Division. University of Missouri, Columbia, Mo

Vetch Culture and Uses. Farmers' Bulletin 1740. December 1934. U. S. Department of Agriculture.

Woodland

Farm Timberlot. Bulletin 407. March 1929. Agricultural Experiment Station. Madison, Wis.

Forests and Floods. Circular No. 19. May 1931. U. S. Department of Agriculture.

Forest Trees and Forest Regions of the United States. Miscellaneous Publication 217. January 1936. U. S. Department of Agriculture.

Forestry and Farm Income. Farmers' Bulletin 1117. August 1933. U. S. Department of Agriculture.

Growing Black Locust Trees. Farmers' Bulletin 1628. May 1930. U. S. Department of Agriculture.

Growing and Planting Hardwood Seedlings on the Farm. Farmers' Bulletin 1123. January 1932. U. S. Department of Agriculture.

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Planting Black Walnut. Leaflet 84. January 1932. U. S. Department of Agriculture.

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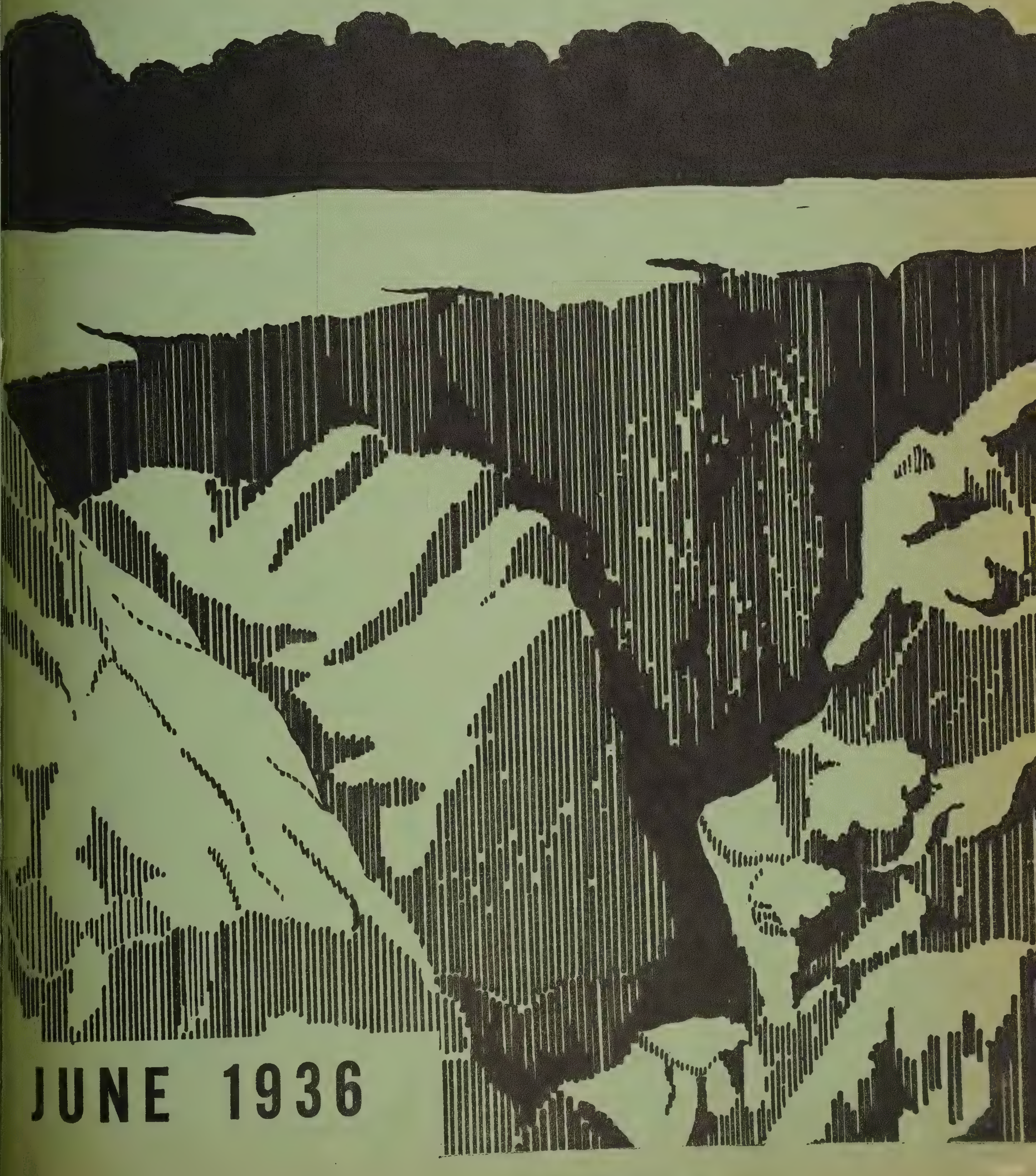

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WELLINGTON BRINK — EDITOR

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HENRY A. WALLACE
Secretary of Agriculture

H. H. BENNETT
Chief, Soil Conservation Service

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ISSUED MONTHLY BY THE SOIL CONSERVATION SERVICE, DEPARTMENT OF AGRICULTURE, WASHINGTON

REJUVENATING NATIVE GRASS PASTURES

By B. C. Langley [1]

The inclination to let native plants fend for themselves and to lavish much care upon imported species or newly developed strains is perhaps common in all agricultural regions. Many native plants, especially pasture plants, will, however, if accorded a minimum of care, give a response amply repaying effort expended in their behalf.

Pasture improvement studies were initiated at the Spur, Tex., Experiment Station in an effort to increase by natural means the stand of native grass on poor pastures and to increase further the carrying capacity of those pastures that already have a fair-to-good stand of grass. The soil on which these studies were conducted is Miles clay loam that has undergone rather severe sheet erosion and is not considered suitable for cultivated crops.

Listed on Contour

During the winter of 1933–34 the pasture land used in these studies was cleared of mesquite trees. A 5-acre block was listed on the contour on May 5, 1934, to a depth of 3 inches, with a two-row lister whose plows were set 39 inches apart. An adjoining block was left unlisted. At this time approximately 70 percent of the surface of the land was covered with buffalo grass (Buchloe dactyloides) in which were a few scattered plants of blue grama (Bouteloua gracilis). The remainder of the surface was bare.

The grass on the listed land grew very little during that first summer on account of the severe drought, the year's rainfall being only 12.88 inches, or 8 inches below normal. It fared much better, however, than the grass on the unlisted land. Thirty-four percent of the latter died during the summer. This decrease in stand was due to the deficiency of soil moisture caused by low rainfall and surficial run-off. On the listed block all the water that fell was held in the level lister-furrows and penetrated into the soil, except for evaporation losses.

Responds to Rainfall

Through the summer of 1935 a better than normal season prevailed. The rainfall for the year was 23.78 inches, or 3.10 inches above normal. Eighty-one percent of this fell during the growing season. The grass on the listed land responded readily, and by midsummer the lister beds and furrows were completely covered with grass, except in a very few places.

To obtain an accurate measurement of the effectiveness of listing, the grass on 32 blocks of 4 square feet each was harvested on both the listed and unlisted land July 15, 1935. Harvesting was done by hand in such a manner as to simulate close grazing. The yield on the listed land was at the rate of 2,423 pounds of air-dried grass per acre and on the unlisted 857 pounds per acre.

Strip Undisturbed

Leaving a strip of land 2 to 5 feet wide between the lister beds proved to be only partly successful in stimulating the growth of grass. The space left undisturbed did not show an increase in the amount of grass produced.

[1] Agronomist, Texas Agricultural Experiment Station, Spur, Tex.

Left, unlisted; right, listed. Pasture at Spur, Tex., Experiment Station.

The blue grama increased from 2 plants per 100 square feet in the spring of 1934 to 6 plants per 100 square feet in the fall of 1935 on the listed land. No increase in grama was observed on the unlisted land.

Few Seeds Produced

The evidence indicates that practically all of the increased growth of buffalo grass on the listed land was not from seeds but was the result of vegetative increase. Very few seeds were produced by this grass for a period of 5 years previous to 1935. This assumption as to the manner of increase is subject to grave error, however, for, since little is known of how long buffalo grass seed will remain viable in the soil, it is possible that seeds produced any number of years ago were caused to germinate under the favorable conditions of 1935.

Be that as it may, the results indicate the feasibility of close listing on contours as a means of rejuvenating pastures and increasing the yield of native grass. The conservation of water by this procedure largely accounts for the beneficial effects.

The practice described, and similar practices, are being employed in an effort to minimize the ill effect of insufficient rainfall on pasture lands by both State and Federal research agencies. The plan of pasture treatment is applicable to a large portion of the territory west of the Mississippi River, especially to those regions that are visited almost yearly by prolonged periods of summer drought.

An interesting side light in connection with the native grass pasture studies is a comparison of the yield of Sudan grass planted in 39-inch rows with the yield of buffalo grass on listed land. The total yield of air-dried Sudan was 1,673 pounds per acre as compared with 2,423 pounds of buffalo grass.

This emphasizes the advisibility of giving reasonable opportunity to native vegetation to fulfill grazing needs before looking afar for new, untried, and unacclimated species.

FLASHES FROM THE TEXAS FRONT

By Wellington Brink

It might have slumbered in Gray's Elegy—this little country burial ground with the legends on its leaning slabs all but obliterated by the chiseling of time and sun and wind and rain. They might have led to an old swimming hole or to a chautauqua tent of boyhood days—these friendly dirt roads flanking the cemetery on either side. But as a matter of cold fact, the whole wooded watershed, so typical of picturesque east Texas, constitutes a practical laboratory which year by year adds to the working knowledge of erosion and its control.

Partners in Progress

As I traverse this region of oil fields, rose culture, fruit production, cotton, corn, legumes, livestock—as I travel the famed blackland belt, and as I view the whole varied panorama of modern-day Texas through the eyes of a soil conservationist—I find it increasingly difficult to segregate in my mind that which is demonstration and that which is experimentation. It becomes more and more apparent that the conservation of soil and water and the control of erosion is a task as large, as diverse, and as challenging as the wasting land resource itself. Through a partnership of research, applied research, and demonstration, we are learning as we do, and we are doing as we learn. Projects are sharing their findings with experiment stations, and to the latter come as eager students the high-booted engineers, agronomists, foresters, economists, nurserymen, and farmers who form the shock troops of the massed effort to save the common estate from the common enemy.

Trees Reduce Run-Off

Both cemetery and roads to which I referred at the outset of this article are contained in a tiny oak-sentineled valley of 7.94 acres, and yet the run-off, by measurement of the Tyler Experiment Station, is from four to eight times slower than on neighboring watersheds which lack trees. Such sludge as does accrue is light and fluffy organic material. The soils of the woodland, which is pastured off and on, are mostly Kirvin and Nacogdoches fine sandy loam. The receptacle used for catching the run-off of the entire area is of the same size as that employed by the station for single-acre measurements elsewhere. What a tribute to the efficiency of forest cover!

Fixed-width, movable strip of a type in vogue near Lindale; 25-foot strips in oats, 75-foot strips in cotton or corn. On successive years strips are moved uphill or downhill.

It is not sufficient, however, simply to appoint a grove of trees as the responsible custodians of soil and and water and let it go at that. The importance of even a single factor in woodland management is brought out sharply a few hundred yards farther along. On a 12½-percent slope supporting virgin timber, the Tyler station maintains 2 plots of one one-hundredth acre each. In March each year, on a day when the leaves are dry, a match is touched to one of these plots. The unburned strip, during a 3-year period experienced a 0.7-percent run-off and a loss of 0.083 ton of soil per acre, whereas the run-off from the burned area was 2.7 percent and the erosion per acre 0.19 ton. That's

Texas seeded ribbon cane on farm near Tyler, planted in June and unfavored with rain until September.

comparatively little, either way, but it reasserts the bad practice of burning. Losses rise as the destruction of the spongy, absorptive, and protective leaf and leafmold covering proceeds.

Other Effective Cover

Of course, we cannot turn back all of Texas' farm acreage to woodland. That would be as impracticable and as uneconomic as the burning-over which intelligent practice condemns. An alternative is to provide other forms of cover for the restraint of roving soils: Alfalfa, Peruvian and common; biennial sweet clovers; small grains, such as oats, rye, barley, wheat; lespedezas; the sorghums, including Sudan grass; vetches and Austrian winter peas, and other winter annual clovers; cowpeas, soybeans. That's what they're doing on the Duck Creek project near Lindale, which I visited. And it's what they're doing—and making scientific observations on—at the nearby experiment station.

In both places a long catalog of plants and practices is being subjected to trial under field conditions, doing for an inquiring and progressive agriculture that which it cannot do for itself. Woolly fingergrass and St. Lucie, which farmers of the community probably had never heard of before and certainly would not have risked trying extensively, have been introduced to pastures and gullies of the region and already are giving evidence of being just what the soil doctors ordered to help prevent erosion-induced land anaemia. Vetches, turned under ahead of soil-depleters like cotton and sorghums, are proving effective soil improvers, as evidenced by the succeeding crop yields.

Plots Compared

The 9 rain gages on the station and the batteries of sludge tanks had a busy time of it in 1935 when there was a total precipitation of 49.06—far in excess of the 31-year average, and when erosion losses mounted higher than during any other year since the beginning of measurements in 1931.

During these 12 months continuous cotton on Kirvin fine sandy loam, in a plot 73 feet long on an 8¾ percent slope, lost 35.91 tons per acre.

This performance took place on typical erodible east Texas soil cultivated in the usual way. It showed to particular disadvantage because it was hugged alongside by another plot of the same size which was given the protection of Bermuda grass; here the loss was comparatively negligible, only 0.03 ton per acre, again testifying to the efficiency of Bermuda in erosion control. The contrast of Bermuda anchorage with the losses under orthodox and unthinking cropping sharpens still further when it is considered that on still another cotton plot of the same size, at a slope of 16½ percent—too steep for effective terracing—the loss was at the rate of 127.09 tons per acre, the equivalent of three-fourths inch of top soil in a single year.

Strip-Cropping Favored

The work on both station and demonstration project points strongly toward the advisability of strip cropping. A strip-cropping combination of red-top, sorghum and cowpeas, established in May, during the remainder of the year lost but 1.53 tons per acre, as opposed to a loss of 10.51 tons from an adjacent check plot in cotton and vetch.

Here, as elsewhere, erosion's ills do not yield to simple capsules. As diagnosis proceeds, the prescription inevitably broadens: rotation, cover crops, green manuring, fertilization, damming, terracing, strip cropping, contour furrowing, a variety of plants and practices adjusted to the needs of the individual "patient."

The Tyler station has its BWS plan, a narrow-strip system of control which is proving highly effective. The "BWS" stands for balk, water-furrow, and strip crop, and it represents a combination of the principal methods, aside from terracing. Among its objectives are (1) increased resistance of crop lands to erosion, (2) reduction in acreage of crops which invite erosion and increase of crops which repel it, (3) an increase in forage crops, (4) soil improvement through legumes, and (5) conservation of moisture for times when it will be needed.

Briefly, the BWS plan embraces alternate strips of *Lespedeza sericea* and cotton. The Lespedeza is grown thickly in the row and is for permanent control. The cotton has four rows to the strip, and is supported by annual fall seedings of vetch. Some of the latter is kept undisturbed at spring plowing in the form of narrow contoured balks between strips. Water-furrows of special construction follow the plowing up of balks in June, so that whatever water is not absorbed by the soil may be led into protected drainageways before it does any mischief.

Practical Objectives

The piney woods section of Texas is a buoyant scene in early spring. Here where science directs its talents toward definite, practical objectives, hope and confidence are as indigenous as the radiant redbud. Like the seed pods of vetches which at ripening burst and throw their contents many feet, modest ideas have been known under this favoring sun to mature and cast their germs long distances. Under such conditions I feel that sure progress will be made toward a sound and permanent agricultural economy.

As one walks the aisles of this vast outdoor laboratory, he is captivated not simply by the scale and the diversity of operations but by the coordination of one experiment with another. For example, strip cropping here does not constitute a study separate from terracing. As tests are made of the behavior of terraces short and long, level and graded, comparisons are also made to determine the relative merits of strip crops located at "midintervals" and at "lower intervals."

The only way really to appreciate what is being done at Tyler is to stand on the lids of its soil bins and see for yourself what happens to miniature fields under various treatments. To get the whole story you must tramp across experimental pastures for a look at such grasses as Bermuda and Dallis. To derive a true insight into erosion-control strategy, you must mingle with the Ramser silt boxes and Parshall flumes, so intrinsic a part of the important terrace-design experiments.

Mangum Terraces

Terraces here are of the Mangum type, 20 to 24 feet at the base, 18 to 24 inches in height. Thus far the bedded terrace has shown 17 percent more soil loss than the flat-planted, and 6 percent less water loss. A two-way plow is in vogue, for shifting the dirt up hill. As the interval between terraces increases, so do both soil and water losses. Thus far, the data

Plot on Tyler Experiment Station testing field contour culture with special plow plan and water-furrowing. The 1935 plan involved cotton-vetch with rye rotation on three strips; Lespedeza sericea *on permanent control strips; vetch balk water furrows between strips.*

suggests that any terrace-channel grade of over 3 inches is too much. Comparative effectiveness of terraced and unterraced slopes is reflected in annual soil losses of 9 tons per acre and 73 tons per acre, respectively.

These are nutshell notes and inadequate to a panoramic portrait of the work at Tyler—but we must pass on to another locale. We must leave our friend B. H. Hendrickson and his competent staff at their experiment station; say our good-byes to Charles B. Spencer and William Porter, his assistant on the Duck Creek project at Lindale. The latter have under their command a record of fine achievement on 74 cooperating farms, where already they have supervised the construction of 133 miles of terraces, have strip-cropped nearly 2,000 acres of valuable lands and have encouraged the removal of more than 1,019 acres from cultivation.

Erosion Conspicuous

Out in Bell County—heart of the famed blacklands of the State—we find sheet erosion giving visual

Once a cultivated field, now a pasture. Gullies in background induced by running rows up and down slope. Gullies still advancing into cultivated ground. Houston black clay, 2 miles west of Rogers, Tex.

warning of impending tragedy to a countryside that is yet young and highly productive. (Picture on page 8.)

It is but 50 to 60 years since the original meadows of little bluestem, big bluestem, and Indian grass first felt the prick of the plow. Yet today nearly every hilltop is streaked with a premature and tell-tale gray. The rich Houston black clay cuddles at the bottom of the slope but from the upper reaches it is migrating in such quantities that the lighter-colored Houston clay subsoil is being exposed with increasing conspicuousness.[1]

Farmers of the region sense what is transpiring. Heretofore, they have, however, been nearly helpless to deal with the problem. Their usual method—a practice so general as to approximate a trend—is to devote the upper slopes to oats and sorghum while letting the cash crops, cotton and corn, have right-of-way on the lower slopes.[2]

[1] It is interesting to note in this connection comparative yields on terraced hillside slopes as recorded by the Temple station. The partial table quoted herewith, we are assured, is a true expression of cause and effect and not an accidental trend.

Terraces	Approximate elevation	Land slope	Total crop yield per acre to date for each crop		
			Corn	Cotton	Oats
	Feet	*Percent*	*Bushels*	*Pounds*	*Bushels*
C–13 (top of slope)	124	4.4	28.47	329.276	6.55
C–14	120	4.4	30.49	409.268	8.59
C–15	116	3.9	35.93	343.914	9.26
C–16	112	3.3	41.43	514.96	12.04
C–17 (bottom of slope)	110	3.0	47.00	691.567	11.84

[2] That this is sound practice is suggested by the fact that no plot on the Temple station, where oats have been the crop, has ever lost as much as 1 ton of soil per acre per year.

So far, so good, according to E. B. Deeter, acting superintendent of the experiment station at Temple. These same farmers, however, usually plant their crops with rows running up and down slopes—and this, avers the same authority, is very bad indeed.

Contraction and Expansion

Observe the behavior of these 15 million black acres under the lusty bludgeoning of sun and rain: cracks 2 to 4 inches wide, sometimes as deep as 4 feet; heavy downpours flowing off fields in sheets and rivers because the high colloidal content of the soil causes it to swell and seal over rather than to absorb. Local builders recognize the expansion and contraction properties of the soil when they use special precautions in laying foundations. Under these conditions it requires intelligent measures to control erosion and to conserve the moisture at times so greatly needed.

To arrive at these measures—and to gain their adoption—is the joint task of the outdoor laboratories at Temple and of the open-air demonstration classroom that is 50 miles long and 20 miles wide. Scientists and demonstrators here again are of the kind that wear khaki and carry the dirt farmer's label, "practical."

Pertinent Results

For example, they've struck off sizable plots on known slopes, divided them by sinking deep partitions, caught all run-off soils and waters, so as to arrive at reasonably accurate conclusions as to the relative merits of several modes of farming.

I was particularly interested in the story—"to be continued"—of plots 23, 24, and 25, of Houston clay. Ranged side by side on a slope of from 4 to 6 percent, they indicate that from July 30, 1933, to June 30, 1935, strip cropping was more than eight times as efficacious in controlling run-off as contour cultivation alone. Indeed, in the first 6 months of last year strip cropping of cotton and oats proved to be 32 times as effective in preventing soil losses as the up-and-down planting of cotton which is generally practiced in this region. Cotton on the contour did a little bit better but also showed to marked disadvantage in comparison with strip cropping. Anyone who is interested in the statistical performance of these plots during the whole of 1935 will want to take a look at the following table. During the year there were 45.01 inches of rainfall—approximately 10 inches more than the average.

Length of slope on which strip cropping may be advisable is yet to be determined. Based on tests of this station, it appears likely that this method is most likely to succeed on 3 to 4 percent slopes for a distance of 600 to 800 feet or more, and where gullies have not become well defined and numerous.

Strip cropping is not a simple panacea on Houston soils, however, for here the problem is complicated by the prevalence of root rot. The disease precludes the growing of legumes and heightens the favor with which winter oats and other winter grains, together with their stubble, must be regarded. Sudan and the sorghums, also of proved value as erosion arresters, are to be crossed off the list in fall and winter. Meadows of little bluestem are an alternative occasionally invoked for protection extending through 6 to 8 years.

Plot	Area in acres	Gallons run-off	Pounds of soil	Run-off, percent	Erosion, tons per acre	Density of run-off	Crop
23	1.38	193,857.27	7,331.82	11.51	2.66	3.78	Strip cropping—2 strips cotton, 2 strips oats, vetch on oats stubble to be bedded for cotton.
24	.14	41,940.84	28,651.07	25.05	104.58	68.31	Cotton rows down slope.
25	1.39	455,058.52	242,873.74	26.81	87.36	53.57	Cotton rows on contour, except at gully

Silting from plot 25, result of 1.77-inch rain on November 20, 1934, Blackland Experiment Station, Temple, Tex. Plot 24 is in the background.

This practically clear water from plot 23, following same downpour, tells an impressive story.

Advanced sheet erosion in the blackland region of Texas. Note black soil in foreground which was formerly on light-streaked patches of distant hills.

It is fairly evident that contour cultivation is not sufficient here but must be supported by strip cropping or terracing, or both.

Buffalo is the No. 1 grass in the region, and it is being pushed for pastures. There is a newcomer, however, that catches admiration here, just as it does at Tyler: St. Lucie, close kin to Bermuda, but short-rooted and therefore less to be feared. Brought over from Florida in March of 1935, by last September it had spread 12 feet. Within its first year in the new clime St. Lucie did much to ingratiate itself, enduring as low a temperature as 6° F. during the past winter and performing such valiant feats in binding the banks of gullies as to bring it to the attention of, and trial by, E. C. W. camps.

Unique Idea

V. W. Woodman, manager of the demonstration on the Elm Creek watershed, introduced me to what looked like "something new under the sun" when he showed me two large drainage outlets parallel and in close proximity to each other. His explanation: "We don't try to drain more than 25 acres with 1 vegetated outlet. A velocity of 5½ second-feet is about right; faster results in cutting, slower results in silting."

Kaleidoscopic notes on a quick tour:

Bermuda outlets are kept grazed. . . . Spreaders serve to define channel level and save ditch if cracking between. . . . Any time there is an overfall here, there ensues cutting and undercutting. . . . Terrace outlets must be good, or they will prove worse than nothing. . . . Contour ridges in pastures made by two rounds with a mold-board plow. . . . Terraces have 24-foot base, 24-inch height. . . . Over 200 small graders loaned to farmers on watershed, who do one-third of the terracing themselves . . . Thirteen hundred miles of terraces on project, 529 farms under contract. . . . In addition to Bermuda, trying in outlets *Lippia*, a running plant used to some extent for lawns in southern California; *Paspalum distichum*, a running relative of Dallis grass; *Panicum obtusum*, vine-mesquite. . . . Asparagus and buffalo grass being tested to determine efficiency in binding soil to prevent cracking around wing walls of structures. . . . Roadside ditch draining 55 acres sloped at sides, provided with stone check dams, planted to Bermuda grass—certain destruction of highway forestalled.

Twelve thousand years would be required to wash away 12 inches of surface soil on the Marshall silt loam in the Mississippi Valley (Missouri) when covered with alfalfa, or more than 100,000 years when covered by native sod; whereas it would require only 29 to 36 years to wash away 1 foot of soil when cultivated to corn on an 8-percent slope.

W. P. A. FIGURES MARCH TOWARD JULY GOAL

By Leo Loxterkamp

Seed collecting.

Driving steadily toward its July 1 man-year quota, the Soil Conservation Service today numbers on its rolls nearly 30,000 W. P. A. laborers, most of whom were formerly on relief.

It has put these men to work sloping gullies, planting trees, building check-dams, constructing terraces and drainage outlets, and otherwise contributing to erosion control. Best of all, it has enabled them to earn a livelihood for themselves and their dependents.

Readily Adapted

The readiness with which relief labor has adapted itself to erosion-control assignments has hastened the process of absorption and has enabled the Service to keep pace with the leaders among Federal agencies in the employment of W. P. A. labor. Although inexperienced and usually unskilled, W. P. A. employees have entered upon their work with enthusiasm and have proved of immense value to the soil conservation program.

The story of how W. P. A. workers were inducted into the Soil Conservation Service may be briefly synopsized as follows:

Appropriation

Under the Emergency Relief Appropriation, an allotment of $25,000,000 (revised in November to $21,000,000) was made to the Soil Conservation Service by the President for work projects, and a warrant for that amount was signed by the Treasury July 1, 1935. At that time there were 40 erosion-control demonstration projects, 76 nursery projects, and 12 erosion experiment stations. In addition, there were 455 C. C. C. camps, with about 90,000 enrollees under the supervision of the Soil Conservation Service.

The new program called for the establishment of 94 new erosion control demonstration projects in 13 additional States, with a relief labor quota of 19,444 man-years to be met by July 1, 1936.

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C. C. C. workers planting pine seeds at South Carolina nursery.

Crew of W. P. A. Negro laborers constructing small cane pumice dams in small gully in South Carolina.

Relief workers finishing rock dam on Missouri farm. Their work will effectively check a gully 9 feet deep from eating back through timothy-clover meadow, and save a well 100 feet above the dam from being washed out.

Strip cropping in practice on an Ohio farm. The oats slow up and strain the run-off from the corn.

AGRONOMIC PROGRAM FOR EROSION CONTROL

By Charles R. Enlow[1]

The agronomic program of the Soil Conservation Service is primarily concerned with the use of field crops, pastures and ranges in such ways as to conserve soil and water, maintain production, and improve the land.

Regardless of the desirability of flood control and the protection of navigation channels and reservoirs from silt deposits, farmers and ranchers cannot be expected to spend more money or labor on land they are operating than will benefit them directly. Erosion-control measures are needed urgently on approximately a billion acres of privately owned crop and grazing land, which constitutes practically half of the total area of the United States.

Owners and Operators Responsible

One and a third billion acres, or approximately two-thirds of the total area of the United States, is used principally for crops and for grazing. On at least 70 percent of the land in crops, and on an even larger percentage of the grazing land, erosion by water and wind is a serious problem. Practically all of the cropland and two-thirds of the grazing land is in private ownership. On this privately owned land, most of which is subject to erosion, soil conservation is chiefly the responsibility of owners and operators.

Formerly, when land was practically free for the taking, location and physical improvements such as buildings and fences constituted its chief capital value. As a result of that situation, agriculture has developed much the same as mining. Farmers have moved westward or cleared more land as their fields have become unproductive, largely as a result of erosion. But unlike a mine, cropland and grazing land by proper management, principally, can be kept permanently productive.

On cropland, if erosion is held to a minimum to preserve the integrity of the soil resource, the intelligent use of crop residues, cover crops, green-manure crops to maintain the content of organic matter, legumes in the rotation to supply nitrogen, and the application of minerals to replace the elements removed by crops, will maintain yields indefinitely.

[1] The author is in charge of the Section of Agronomy and Range Management, Soil Conservation Service.

Vegetation is the outstanding agent in erosion control. It is the source of organic matter which has such a favorable effect upon the texture of the soil, particularly its water-holding capacity. The more water the soil can hold and the longer it can be retained, with proper soil aeration, the smaller will be the run-off and the greater will be the growth of additional vegetation. Plants which lie close to the ground, stand close together and have extensive root systems, are best for protection against water and wind. Such plants should be grown in alternate strips with plants which do not have such erosion-resistant qualities. In the case of wind erosion, the roots must hold the tops or stubble of dead plants securely untii the coming of the next crop affords protection.

The other principal agent of erosion control on crop land is tillage. Tillage affects the physical arrangement of the soil and consequently the rate of run-off, and influences the soil burden of the water which is not held on the land. The tillage method should leave the soil in condition to absorb the maximum amount of rainfall, and to retard the speed of run-off. By following contour lines in tillage operations, and by leaving the surface soil in a rough condition, many miniature dams are erected to slow run-off and allow the rain time to penetrate. When there is considerably more moisture than the soil can hold with the aid of all practical methods of tillage and vegetation available, terraces are in order if the land must be kept in cultivation and if the benefits are sufficient to justify the expense.

Wind Erosion Control

To check wind erosion, a similarly rough soil, which may be procured by using a lister at right angles to the prevailing wind, is helpful; however, if there is much run-off the furrows should be on the contour, as the extra moisture thus saved encourages the growth of vegetation.

For both wind and water erosion, allowing crop residues to remain on the surface as long as possible after crops are harvested and keeping such residues on or near the surface at least until new plant cover is established, is one of the most effective means of control. When such residues are either absent or inadequate, and sufficient moisture is present, cover crops should be sown to protect the soil until time for seeding the next regular crop.

Erosion control on grazing land in the East is principally a matter of grazing the pastures sufficiently close to promote a good sod of such plants as bluegrass and white clover, and yet not so close as

Natural recovery of range vegetation in New Mexico resulting from 2 years' protection from grazing.

A cover crop of rye seeded in a cornfield in Missouri to protect the soil from erosion until the next regular crop is planted.

to weaken the plants and leave the soil poorly covered. Fertilizer may be necessary to get a satisfactory cover on eastern pasture lands. Contour furrows decrease run-off during hard summer rains, improve the cover, and reduce the danger from overgrazing by increasing the production of vegetation.

On Western Ranges

On the western ranges the maintenance and restoration of the native grasses and browse is the principal problem. Proper seasonal use is one of the most effective methods where several types of range are available. It consists principally of keeping the stock off of the spring-fall range and the summer range until the vegetation has made a considerable part of its potential growth. In the case of the bunch grasses, protection should continue during alternate years, or every third year, until the seed matures. It is also necessary to avoid grazing the winter range out of season. To accomplish this, there must usually be a reduction in the number of livestock, an increase in the supply of supplementary feed, or more efficient use of the present range. The increased vegetation facilitates greatly the rate of water absorption by the soil, retards the run-off, and protects the soil against the wind. Contour furrows which hold the water on the slopes until it can penetrate the soil cause remarkable increases in the density and quantity of vegetation, thereby protecting the soil more adequately and improving the carrying capacity.

Duties of Agronomists

The duties of the agronomists of the Soil Conservation Service working on projects and in E. C. W. camp areas consist principally of planning the use of crop rotations, cover crops, and pastures. Such planning includes rates, methods and time of seeding; fertilizing; tillage practices effecting soil and water conservation such as contour tillage, strip cropping, contour furrowing, and rough or trashy tillage; and the management of grazing animals on pasture and cropland to protect the growing plants and crop residues.

Range examiners are concerned principally with determining the carrying capacity and the soil-conserving qualities of the native forage and with developing plans for improving and adding to these properties of the range. Consequently, they must deal with natural and artificial revegetation, time and intensity of grazing, the optimum use of water where it falls or can be diverted, and also practices affecting the time and intensity of grazing. Other phases of livestock management such as supplemental feeding, water development, salting, bedding, and trailing must be given attention in attempting to maintain or secure better vegetative cover.

Controlling Rodents

Occasionally both agronomists and range examiners must give consideration to rodents, insects, and plant diseases which either destroy the effective cover or reduce it to such an extent that erosion either results directly, or follows overgrazing by livestock.

Failure to use cover crops and contour tillage has practically ruined the soil and the orchard on this California hillside. Note the contrast with the adjoining grassland.

Such pests as jack rabbits may not appear in serious numbers until overgrazing has given them an advantage over their natural enemies. In such cases, reducing the rodents as well as the livestock may be justified to restore a balance, provided the cost is commensurate with the amount of soil conservation effected.

In putting such methods into practice on the demonstration areas, it is necessary to make sure that the specific procedures are in accord with the results secured by the experiment stations of the States in which the projects are located, and that such procedures are approved by the experiment station and extension representatives concerned. It is also necessary to coordinate such practices with the findings, responsibilities, and policies of the various bureaus of the Department of Agriculture interested in this field, such as the Bureaus of Plant Industry and Agricultural Engineering, the Forest Service, and the A. A. A. In the case of range management, cooperation is necessary with the Division of Grazing, Department of the Interior, and with the Indian Service on Indian reservations.

Must be Practical

Above all the methods being used on demonstration areas should be so practical that they can be readily adopted by farmers and ranchers. Either the methods must fit into the farm operations as they are being conducted without requiring much cash outlay and additional labor, or they must be so obviously advantageous and profitable that the necessary changes will be made voluntarily

(Continued on p. 15)

FROM SEEDLING TO FENCE LINE IN SIX YEARS

A soil-conservation-conscious farmer—N. M. Tucker of Dresden, Weakley County, Tenn.—has demonstrated how to stop erosion by the use of black locust. Starting from scratch 6 years ago, Tucker not only stopped gullying on the breaks in one of the sloping fields he had cleared, but produced a crop of fence posts at the same time.

When gullies began to form after 3 years of cultivation in this particular field, Tucker consulted his county agent, who advised him to plant black locust on the eroding area. The seedlings quickly controlled erosion, allowing Tucker to continue farming the upper part of the field where he was able to grow a fine stand of lespedeza.

Although good forestry practice recommends that black locusts usually should not be cut for posts sooner than 10 to 12 years after seedlings are planted, this farmer was able, by selective cutting, to obtain within 6 years enough posts to fence a truck patch.

The black locust is being used extensively by the Soil Conservation Service in its program of erosion control, according to F. E. Currie, forester of the Service at Jackson, Tenn. The tree is a legume. Its fast-growing root system stabilizes the soil and allows native hardwood trees to become established. These factors, coupled with very tangible returns in the form of posts, wood, and other products, cause the black locust to be widely used by the Soil Conservation Service. In Tennessee alone, the Service is planting 5 million black locusts this year. Although this species constitutes only 29 percent of the tree-planting program of the Service in the season of 1936–37, as against 68 percent in 1935–36, it is sure to continue in importance in the years to come.

W. P. A. FIGURES MARCH TOWARD JULY GOAL

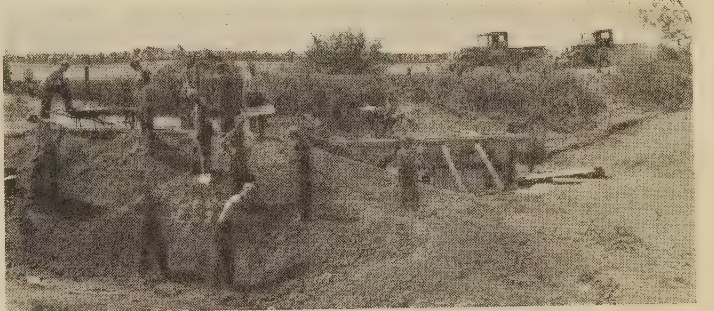
(Continued from p. 9)

The expenditure of this $25,000,000 was subject to certain restrictions: First, that 90 percent of the labor to be used in carrying out the program be drawn from relief rolls; second, that on an average 1 man-year of employment for persons taken from relief rolls must be provided for every $1,080 expended; third, that an assured monthly wage not subject to interruption on account of weather or other temporary conditions beyond the control of the worker, should be the basis of work relief payment.

Steps were immediately taken to set up the administrative procedure and, proper clearance having been obtained from the Department of Agriculture, on August 3 the Soil Conservation Service issued its first instructions for operating under the new program. By the end of August, 19 of the new projects were in operation, employing a total of 4,701 persons on relief. During September and October employment continued to rise at an increasing rate, approximately 2,200 being added per week. By November 1 several States passed their quotas for that date. At this time all the new proposed projects were established and in operation. This enabled the Soil Conservation Service to meet the wish of the administration that each agency have its full relief labor quota at work by November 1. Success was due to the enthusiasm with which each regional officer launched his projects on the new W. P. A. program.

By April 15, 1936, the Service had furnished 13,984 man-years of relief labor employment, which was 72 percent of the revised July 1, 1936, man-year quota. A recent rescission of W. P. A. funds somewhat reduced the quota, which will be attained by the end of the fiscal year.

Constructing drop inlet dam in Missouri in connection with cement culvert, the result of which will be to control large branched gully on upper side of highway.



W. P. A. crew completing wire check dam in Iowa. Brush and posts were taken from hedge needing thinning.

FARM MANAGEMENT UNDER STUDY IN OHIO

Farm-management practices during the past 50 years are under cooperative study by the Ohio State University and the Soil Conservation Service. An effort will be made to discover, if possible, why soil fertility is maintained on some farms and depleted on others similarly situated. Data will be gathered by personal interviews with present owners or tenants, previous owners or tenants, and neighbors.

The plans for the study were prepared by Dr. J. I. Falconer, of the department of rural economics of the Ohio State University, and E. H. Reed, of the Farm Management Section of the Soil Conservation Service, assisted by Dr. Walter J. Roth, in charge of economic studies, Division of Research, Soil Conservation Service. Actual field work is to be done by R. M. Isler, of the Ohio Agricultural Experiment Station, and Isaac Shepard, of the Soil Conservation Service regional staff.

Collecting Information

Approximately 6 months will be required by these field workers to gather historical data on some 40 farms on the Salt Creek demonstration area near Zanesville and approximately 20 farms in each of the areas with headquarters at Hamilton, Mount Vernon, and Wooster.

The farms upon which these studies will be conducted are grouped in pairs. The farms in each pair are similar in soil type and topography but differ in degree of erosion. By selecting pairs which are similar in soil type and topography, two of the variable factors over which the farmer has no control are eliminated as far as possible and the study is confined to problems of land use and soil conservation practices which are affected by the operator.

History of Farms

A history of the farms, covering the past 50 years, is to be obtained. This includes the history of ownership, tenancy, type of farming, proportion of acreage in clean-cultivated and close-growing crops, crop yields, soil fertility, and soil conservation practices. Information also is to be obtained on the size of the family in proportion to size of farm and unusual demands for money which might cause the operator to work the farm especially hard, such as advanced education of children, large doctor bills, or heavy indebtedness.

The study is an attempt to determine what factors lead to the depletion of soil productivity on some farms and what factors lead to the conservation of soil on others.

FOREST LITTER, FREEZING AND RUNOFF

Animal life hibernating during winter underneath a good forest cover should be as snug as the proverbial bug in a rug. Tests on unforested areas this past winter found the ground frozen to a depth of 20 inches, according to investigations made on experimental plots near Zanesville, Ohio, region 3. Within the forested plot where snow persisted on the forest floor, in combination with a normal forest soil cover, little or no frost had entered the soil. Moreover, the effectiveness of ungrazed and unburned timberland in preventing run-off of rain and melting snow was demonstrated.

The studies, made by J. A. Gibbs, in charge of woodland management for region 3, show that a major factor in preventing loss of water is the prevention of freezing afforded by a good cover of forest litter.

Cover Lessens Freezing

Forested plots and unprotected adjacent areas on the Northwest Appalachian Erosion Experiment Station were checked during the severe weather and again after the spring thaw. Results showed that soil beneath good forest and snow cover is not subjected to such extensive freezing as are the unprotected open fields. This conclusion is further substantiated by data obtained by Mr. Gibbs during the winter of 1934–35.

During January and early February of 1936, air temperatures as low as 22 below zero were reported in Zanesville and vicinity. The period of excessive low temperature persisted for 2 weeks or longer.

In other sections of the forest plot where snow had disappeared and where the leaves and soil cover were subnormal in thickness, the ground was frozen to a depth of 4 to 6 inches.

"The ability of normal forest soil to retain its porosity and water-holding capacity under such conditions is made impressive by these data, and is most important in conserving winter rainfall and snow water, and storing it in the soil against prolonged dry periods", said the forester.

During the second week of February, when rain fell and there was some thawing, Gibbs found no run-off from the forested plot. Thawing was slight in the woods, while water literally poured off slopes in open fields. Fortunately, the soil there was frozen so that the water did not carry much silt.

DEATH TAKES MAJOR FLEMING

Maj. Burton P. Fleming, regional engineer of Region No. 8, died at Glendale, Calif., May 26, 1936. He had been with the Service since December 1933, when he became regional director of the Gila erosion-control project. In June 1934 Major Fleming was called to Washington to take charge of the branch of engineering, later returning to Albuquerque as chief engineer for the southwest region.

Major Fleming was born at Valley, Nebr., 1881. He was educated at Utah Agricultural College and Cornell University, obtaining his M. E. degree in 1906.

The next few years were spent on hydraulic and irrigation engineering jobs in the West and Middle West. During the World War he served as captain of engineers in France. In 1929 he went to New Mexico as manager of the Elephant Butte irrigating district. In 1932 he became dean of engineering, New Mexico State College, obtaining leave of absence to enter the Soil Erosion Service.

In addition to consulting work, Major Fleming was often called upon to assist in selecting sites for, and constructing dams, and power, hydroelectric, and steam-heating plants. He was a frequent contributor to the scientific press.

SCHEDULED MEETINGS OF INTEREST

Society	Date	Place of meeting
Biological Society of Washington		Washington, D. C.
American Society of Agricultural Engineers	June 21–25, 1936	Estes Park, Colo.
American Society of Civil Engineers	July 15–18, 1936	Portland, Oreg.
	Oct. 14–16, 1936	Pittsburgh, Pa.
American Physical Society	June 17–20, 1936	Seattle, Wash.
	June 22–23, 1936	Rochester, N. Y.
	October 1936	New York, N. Y.
	Nov. 27–28, 1936	Chicago, Ill.
	Dec. 28–30, 1936	Atlantic City, N. J.
American Society of Planning Officials		
American Meteorological Society	June 11–12, 1936	Kansas City, Mo.
	June 16–18, 1936	Rochester, N. Y.
	June 16–20, 1936	Seattle, Wash.
	December 1936	Atlantic City, N. J.
American Association for Advancement of Science	June 16–20, 1936	Rochester and Ithaca, N. Y.
	Dec. 28–Jan. 2, 1937	Atlantic City, N. J.
	Summer 1937	Denver, Colo.
	Dec. 27–Jan. 1, 1938	Indianapolis, Ind.
	Summer 1938	Eastern Canada.
Oregon State Agricultural College	July 27–29, 1936	Laramie, Wyo.
National Association of Audubon Societies	Last Tuesday, October 1936	New York, N. Y.
American Soil Survey Association	Nov. 17–20, 1936	Washington, D. C.
Association of Land Grant Colleges and Universities	Nov. 16–18, 1936	Houston, Tex.
American Geographical Society of New York	November 1936–April 1937	New York, N. Y.
National Geographic Society	November 1936	Washington, D. C.
International Society of Soil Science	do	do.
The Geological Society of America	Dec. 28–30, 1936	Cincinnati, Ohio
American Farm Economic Association	Dec. 28–30, 1936	Chicago, Ill.
The Society of American Foresters	January 1937	Seattle, Wash., or Portland, Oreg.

AGRONOMIC PROGRAM FOR EROSION CONTROL

(Continued from p. 11)

on an extensive scale. The farmers will continue to produce principally the products which years of experience have shown are best adapted to their soil, climate, and individual resources, and are readily marketable to their advantage. They will continue also to use principally the equipment and power which is available on the farms. Corn, cotton, cattle and sheep will undoubtedly continue to be the principal products in the Corn Belt, the Cotton Belt, and the West, respectively.

Vegetation introduced primarily for soil-erosion control must either supplement the staple crops or forages produced at present without curtailing seriously their production, preferably cheapening, indeed, the cost of production, or it must replace a part of such staples to the farmers' gain. New arrangements of vegetation on the land, such as strip cropping if to be continued, must be such as to maintain or increase yields without increasing production costs. New tillage practices must be suitable principally for the implements at hand and for use with the crops grown at present on the farms.

Moisture at Seeding Time

Some of the most effective methods require no additional cost or effort. For example, wind erosion can be quite effectively controlled on the southern high plains by planting winter wheat only when there is sufficient moisture at seeding time to insure a good fall growth which will afford effective protection during the windy season of winter and spring. Heavy stubble left standing through the winter gives ample protection in the spring. In fallowing, if the stubble is kept on or near the surface and the soil is not pulverized, serious blowing is usually prevented. If more protection is necessary, double rows of grain sorghum or Sudan should be planted 10 or 15 feet apart, depending upon the width of the grain drill. When seeding time comes, if there is not sufficient moisture to produce good cover, seeding should be postponed, as long-time records from the State experiment stations and the Bureau of Plant Industry show that a good crop cannot be expected if moisture is scarce at seeding time. The wheat stubble and the sorghum, if not grazed, will afford protection over winter and through another season of fallow. By following this method, seed is not wasted in soil that is too dry to grow a cover in the fall, the minimum of power is used in fallowing, and the soil is kept where it belongs until conditions are right for a good yield of wheat.

Economy Important

In areas where the cost of the necessary agronomic erosion-control measures are in excess of what farmers and ranchers can afford to put into practice, more economical methods must be found. If more expensive methods are to be practiced extensively by farmers on neighboring land they must be given assistance.

It seems apparent that the Soil Conservation Service might profitably conduct two types of projects, drawing a clear distinction on the basis of purpose: One, where the agronomic methods are so practical and inexpensive and the benefits so obvious that neighboring farmers and stockmen would readily apply such methods on their own land; the other, where proportionately greater expenditures in relation to returns are justifiable because of the menace of floods, duststorms, or encroaching sand dunes to adjoining lands, towns, or cities.

BOOK REVIEWS AND ABSTRACTS

By Phoebe O'Neall Faris

A Contribution from the Soil Conservation Service Library

BIOLOGICAL PROCESSES IN TROPICAL SOILS. By Alexander Steven Corbet. London. 1935.

From the viewpoint of the bacteriologist, Dr. Corbet tells the engrossing story of the soils now existent on what is left above the sea of the ancient continent of Sundaland.

It was in the Secondary Era, according to the history told by the rocks, that Sundaland rose from the bottom of the sea to begin the long wait of an age or two while wind and water made habitable land of its eozoic rocks and volcanic debris. During this long wait the shaken land found its equilibrium, with low plains sinking again beneath the sea to form the famed Sunda Shelf, and highlands, with lofty peaks and tablelands, rising to stand out as the Malaysia of today.

The Malay Peninsula, Sumatra, Borneo, Java, Palawan, and the adjacent small islands, are of the Indo-Australian faunistic region, with a climate characterized by uniformly high temperature, heavy rainfall and extremely humid atmosphere, and with laterite soils of low silica and high sesquioxide content. In all these countries the geological formation, climate, flora and fauna are similar, and, in the natural state, the land is covered with dense primeval forest. With the exception of Java, these lands still retain most of the original jungle, and on this account are of particular interest to the soil bacteriologist having, as he does, the advantage of studying the activities of micro-organisms with two important factors, temperature and humidity, maintained at constant level.

The climax of vegetation in Malaysia is the tropical rain forest, with an abundance of epiphytes and trailing lianas contributing to the riotous jungle growth; but, when primary forest is felled and cleared and left uncultivated, the dense leathery spear grass, known as lalang, takes hold and soon covers the land. Apart from cultivated crops, the primeval forest, and the lalang regions which sometimes extend far up into the highlands, the only other vegetation of any extent is the mangrove forest found in muddy estuaries and along sheltered coasts.

As to the soil fauna of Malaysia, the termites perform the truly important functions of soil conditioning. These creatures of the soil surface debris, by their ceaseless movements, hasten the decomposition of decaying vegetation and increase aeration. The ants, too, are important, though in a lesser degree, as they are responsible for the speedy decomposition of animal organic matter. The soil fauna of the mangrove association differs entirely from that of primary or secondary forest as it consists largely of burrowing species of Crustacea, and it is doubtful if the tunnels made by these creatures represent any considerable soil movement.

Dealing with soil micro-organisms, Dr. Corbet presents a detailed study of the factors affecting the abundance of bacteria, fungi, and protozoa in the soil. Factors discussed are temperature, soil moisture, aeration, soil reaction, mineral content of the soil, vegetation, and depth. An interesting table is given showing variation in numbers of micro-organisms with depth under the primary forest and under a cover of *Centrosema pubescens*, the latter area of which had been water-logged before it had been cleared of forest. The bacterial growth curve is given, with representations of the lag phase of bacterial population numbers, the logarithmic increase phase, the stationary phase, and the phase of decline. There follows a discussion of plant constituents and decomposition by micro-organisms, with measurement of carbon dioxide evolution which shows that microbiological activity in Malayan soils is 10 times greater than that in temperate regions during the summar months.

In considering the nitrogen cycle, the author states that in cleared areas exposed to the sun, nitrogen disappears rapidly from the soil until a new and lower level is reached. With a subsequent reappearance of vegetative cover and consequent shading of the soil, there is gradual increase in the nitrogen as a result of the activities of symbiotic and free-living nitrogen-fixing bacteria. It appears, therefore, that whether a soil is gaining or losing nitrogen depends largely on the amount of solar radiation received.

At the close of the scientific discussion some practical considerations are given. They include the effect of burning-over cleared land on the soil mineral salts, on the organic matter, and on the soil micro-flora; pests and diseases harbored by decaying timber; leguminous cover plants and shrubs; natural cover values and the evils of clean-weeding; the defects of the Birkemose forestry system, and the effect of fertilizers on Malayan white alluvial soils and red volcanic soils.

The appendix contains standard methods for the examination of soils, and a classification of soil bacteria. There are 16 plates illustrating various Malaysian land formations and vegetational phases.

AMERICAN CONSERVATION IN PICTURE AND IN STORY. Compiled and edited by Ovid Butler. 1935.

In this miscellany the story of conservation is told, beginning with earth out of chaos and following through earth changes and the countless years that have gone into the making of our land sculpture and the formation of its natural resources.

How the earth is believed to have been formed; creatures of prehistoric ages which inhabited its forests and its swamplands; the Inland Empire and the "Shining Mountains" of pioneer days; the massacre of the greatest forests; the dawn of conservation and forest protection—these are but a few of the phases as told, graphically and briefly, in picture and story.

For those who desire more detailed information on the subjects presented, some 350 references are given at the end of the book.

WILDLIFE HANDBOOK. United States Forest Service. Region 9. 1936.

Outlines the policies, objectives, and instructions governing wildlife management in the region, with working instructions in detail of all phases of wildlife conservation. Concerns fish management, upland game, furbearers, nongame species. Appendix contains: Characteristics of lakes and streams according to physical, chemical, biotic factors, and successions in water; illustrations of common fish with food requirements; important duck foods; illustrations of tracks of furbearers; mixture of seeds for food patches; properties of typical plants suitable for escape coverts for upland game.

DUST. By S. Cyril Blactin. London. 1934.

A study of dust, prehistoric and historic, its geologic history, its nature, its chemical composition, its determinations and effects, and its variations with regard to human and animal life and activities.

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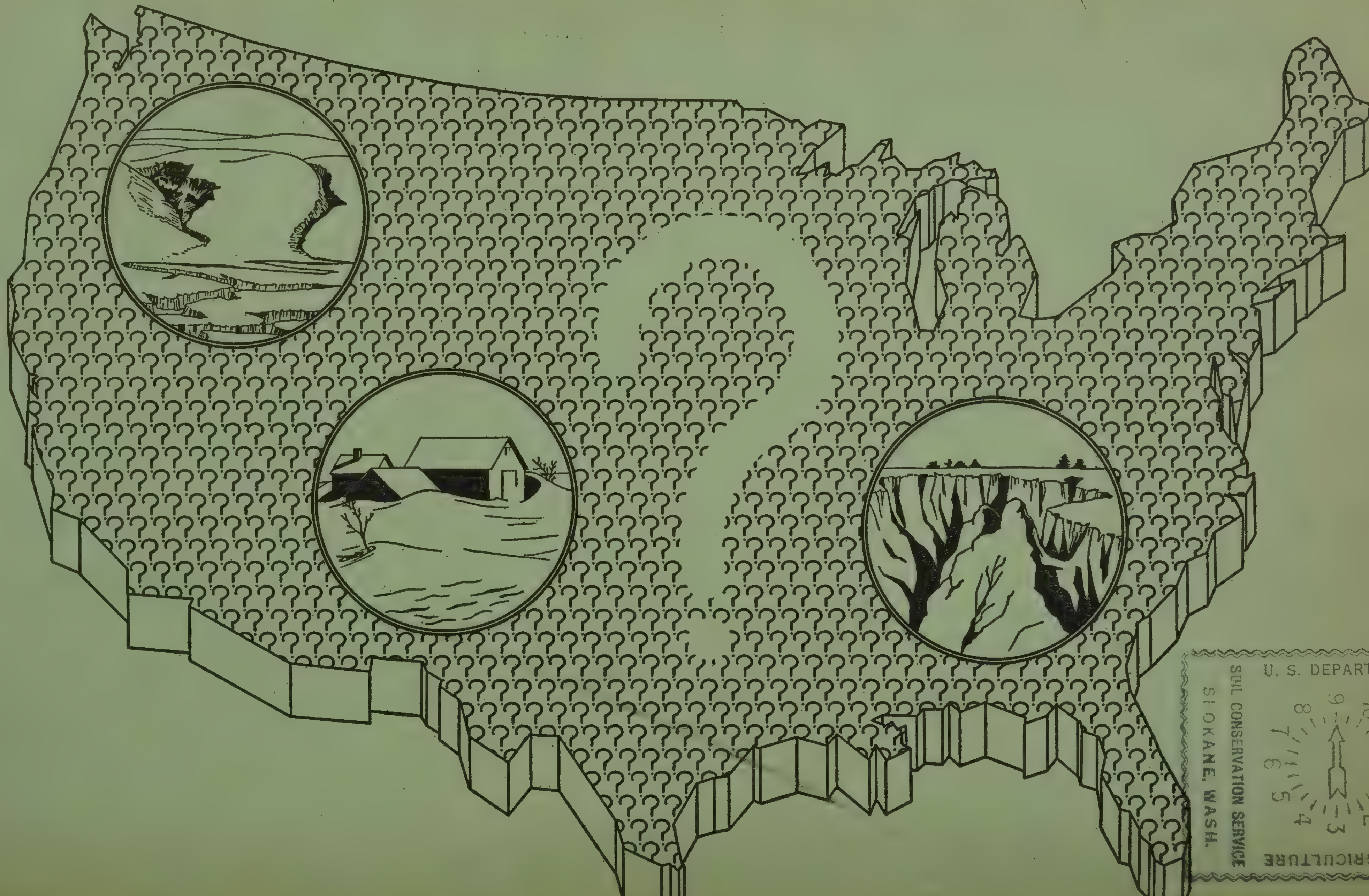

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